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ANNUAL REPORT

for the
Year Ending October 31, 1940



Connecticut
Agricultural Experiment Station
New Haven



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LETTER OF TRANSMITTAL

January 15, 1941

To His Excellency

Robert A. Hurley,

Governor of Connecticut

Sir:

We have the honor to submit herewith the Annual Report of The Connecticut Agricultural Experiment Station for the Station year ended October 31, 1940. This is a brief statement in two parts:

1. A Report of Progress, which is in the form of the Report of the Director to the Board. This includes the list of publications for the year and the active projects.
2. The Report of the Station Treasurer for the fiscal year ended June 30, 1940.

Respectfully yours,

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

THE BOARD OF CONTROL

E. C. Schneider, *Secretary*.

REPORT OF THE DIRECTOR

FOR THE

YEAR ENDING OCTOBER 31, 1940

*To the Board of Control of the
Connecticut Agricultural Experiment Station:*

THE application of scientific principles to the solution of the practical problems of the farm is now so common that we are apt to overlook the fact that this is a relatively new thing in the long history of agriculture. The year 1940 marks the hundredth anniversary of the publication of Liebig's celebrated *Report to the British Association for the Advancement of Science* in which, for the first time, the services chemistry can render to agriculture were clearly discussed in language the layman could understand. This report was the forerunner of a series of essays and textbooks from Liebig's pen that completely altered the practice of agriculture and led to the establishment of experiment stations throughout the world. From an art in which tradition, and often superstition, played a dominating role, agriculture has been transformed into an applied science which is, even today, still in a youthful phase.

Research into the fundamental principles that control the behavior of living things, whether plants or animals, has contributed more than any other factor to this transformation and is thus the first obligation of experiment station workers. However, such research is frequently of a nature that seems far removed from the growing of crops and the care of animals. Nevertheless the information gathered fits into its proper place and leads finally to an enlarged understanding of nature, without which progress would be impossible.

Thus when Osborne and Mendel, in 1918, showed that chickens can be raised in cages on artificial diets, no commercial application of their procedure could have been foreseen. Previously, exercise in the open air, contact with the ground, and a supply of green food were regarded as essential for the growth of chickens to maturity. Their experiments proved that successful growth was readily secured on purified experimental diets, provided the proper vitamins were made available. Their objective was to find whether chickens could be used as experimental animals, for, if so, the cost of certain types of nutrition experiments could be reduced. Chickens are now raised that have never seen the light of the sun, nor have ever had the privilege of scratching in the barnyard, and the use of cod liver oil in the diet of chickens has become a commonplace. Yet this contribution to the poultry industry is an outgrowth of fundamental

studies that had a wholly different purpose, and furnishes an illustration of how great an influence may be exerted by well-conceived experimentation.

Such examples appear constantly in the work of this and the other agricultural stations. The organic chemist working on the most abstract problem may synthesize a new compound that is found to have fungicidal properties. The biologist, the geneticist, the mathematician, all have essential contributions for agriculture.

PREVIEW OF STATION WORK IN 1940

THE WORK at the Experiment Station combines research and service, the service frequently depending upon past or present research. The Department of Analytical Chemistry is a good example of this interrelationship. Charged by the State with the duty of inspection of fertilizers and feeds, it collects and examines samples of these materials sold in Connecticut and publishes the findings. The result has been steady improvement in standards in these fields. In collaboration with the Dairy and Food Commissioner, a similar service is carried on in connection with foods and drugs for the benefit and protection of the public. The department devises, or collaborates with other chemists in devising, better methods of testing products that come under its jurisdiction. A summary of the inspections of 1940 is included in the next section of this report, page 399.

The chemical changes that take place in the various parts of a plant during growth have long been a subject of study by station biochemists. Part VIII of this series of investigations has been completed and is reported in Bulletin 442. It deals with the effect upon tobacco leaves when nitrogen is supplied in the form of nitrate and of ammonia during growth. The chief result is a variation in the organic acid content, which may be significant for practical application in the future. Page 402.

Edestin, derived from hempseed, is a standard protein that has been used in the diet of laboratory animals for many years. Recently legal restrictions regarding marihuana have made it difficult to obtain untreated seed. Searching for a substitute for edestin, the laboratory has extracted proteins from cucurbit seed and has been testing the physical and chemical properties of these. The protein from pumpkin seed appears promising and its nutritive values will be compared with those of the edestin. Page 404. Other phases of the work in biochemistry are summarized on pages 399 - 406.

The Genetics Department also is interested in how plants grow from the viewpoint of cell development and the changes that influence normal and abnormal growth. An understanding of the obscure factors governing inheritance eventually made hybrid corn possible. Today better squash, strawberries, corn and other crops are being developed because research has pointed the way of controlling inheritance. Some of the research studies now in progress, as well as practical results of the investigations, are reviewed on page 417. In the same section are given the 1940 findings on hybrid squash. Ex-

periments indicate that the second generation produces as many marketable fruits early in the season as the first generation hybrid, the seed production of which is expensive. This means that the seed of the hybrid squash may be saved and planted with the expectation of obtaining a similar crop the second year, a discovery that may have far-reaching significance for the seed industry.

Still another angle of the science of the growth of plants is the work of the Soils Department. Here we find interest in the needs of the different crops, how the physical and chemical make-up of the soil affect growth, and what can be done to adjust discrepancies. Two years ago the apple crop of the State was badly damaged by internal cork, later found to be caused by boron deficiency. Subsequent tests and greenhouse experiments with orchard soils have provided a means of detecting and correcting such a condition. Page 424. Last year marked the end of a ten-year study of the management of soils for intensive vegetable cropping in the Connecticut River Valley, and results are presented in Bulletin 439. Although the experiments were performed on the sandy soil of the plots at Windsor, the principles derived from the studies may be applied in other sections of the State. The work of the Soils Department is summarized on pages 424 - 429.

Reference to notes of the Forestry Department, page 414, shows that research and service in the past year have concentrated on new outlets for Connecticut wood. Woodland covers more than 50 percent of the acreage of the State. In the interests of economy and better silvicultural practices that will eventually increase timber value, the Station cooperates with other agencies in various projects. The development of a low priced movable kiln for producing charcoal and the treatment of wood with zinc chloride to make it more durable for posts and poles are two phases of the work for 1940.

The nature of diseases affecting plants and their control have been problems of plant pathologists and botanists at the Station since 1888. A new development in this work is the study of organic chemicals for specific effects on groups of plants or in connection with particular disorders. The first fruit of this research is the finding of a material that protects lima beans from rot and promotes growth of the young plants. Page 423. . . . A project in chemotherapy with the object of controlling or curing Dutch elm disease was started in laboratory and field in 1940. The injection of 8-hydrox-quinoline sulphate has a marked detoxicating effect on infected trees and promises a method of protection for valued individual specimens. The work in connection with Dutch elm disease has been carried by three Station departments and a review of the present situation is given on pages 412 and 421.

Among the services performed by the Plant Pathology Department are the testing of seeds for purity and germination in collaboration with the State Department of Agriculture, and the diagnosis of disorders in specimens of sick plants submitted by residents of Connecticut. In the latter case, whenever possible, suggestions are

offered for control. . . . The department review includes the study of defoliation diseases, control of chrysanthemum nematodes, methods of determining spray coverage on cucurbits and on apples, and X-disease of peach.

The Department of Entomology is also responsible for certain services, such as inspection of nurseries and apiaries, in compliance with State Law. In addition, the staff studies the biology and habits of the insects affecting crops, so that methods of control may be effectively developed. A large-scale experiment on the farm of a vegetable grower in 1940 demonstrated that it is economically practical to control the European corn borer on early sweet corn . . . One of the most serious problems of the department is the Japanese beetle which continues to increase and spread through Connecticut. Control investigations include the use of insecticides, fungicides and a bacterial disease . . . Information is gradually being accumulated concerning the effect of the Oriental fruit moth parasites on infestations of peaches. There is also a promising new material, a xanthone known as "Genecide", that offers possibilities as a practical insecticide in peach orchards. A successful demonstration of treating large areas infested by the gypsy moth by use of an autogiro was completed in 1940, and results indicate the possibility of markedly reducing the cost of applying insecticides to woodlands. These and other phases of entomological work in progress during the past years are summarized on page 406. . . . Further details are given in the *Report of the State Entomologist* which appears in June.

Unlike other departments of the Station, the Tobacco Substation at Windsor combines all research, working on a single plant. Projects at the Substation include soil management, plant pathology, plant breeding and entomology. During 1940 the Substation issued a handbook that gives growers adequate information on diseases of tobacco in the Connecticut Valley to enable him to avoid or reduce losses. The plant pathologist in charge also publishes an annual report of the work at Windsor. In briefer form the investigations are reviewed on page 429.

THE STATION YEAR

New Buildings and Equipment

With the completion of buildings now under way, the Station looks forward to a period of accelerated service to agriculture. Three new greenhouses provided for by the 1938 legislature will be ready for midwinter research in 1940-1941. These will relieve congestion in the old greenhouse, and allow better facilities for research in plant breeding, entomology and plant pathology. The laboratory at the Tobacco Substation at Windsor is practically ready to be occupied. It will provide for expansion in all phases of tobacco work, which have been cramped by limited quarters in the small original building. The structure at New Haven, combining auditorium, entomological laboratories and garage under one roof, also shows signs of nearing completion.

Appointments and Staff Changes

There have been a number of changes in the staff during 1940. In January, Dr. C. I. Bliss, Consulting Biometrician, spent three weeks at the Station lecturing and discussing problems with individuals on the staff. Dr. Bliss was formerly connected with the Bureau of Entomology, U. S. D. A., and spent two years working with Dr. R. A. Fisher at the Galton Laboratory, London, and two years as Biometrician at the Entomological Institute at Leningrad, U. S. S. R. His work at New Haven proved so worth while that he is returning to the Station next year for a longer period.

Dr. R. B. Friend has added to his duties as State Entomologist those of Assistant Director.

In March, Dr. Stuart LeCompte, Jr., received the appointment of Assistant Plant Physiologist at the Tobacco Substation, filling the post left vacant by Dr. O. E. Street. Dr. LeCompte came from Johns Hopkins University where he completed both undergraduate and graduate study.

Two new members have joined the Department of Plant Pathology this year. The seed testing work is now concentrated in the hands of Miss Frances Johnson who received her master's degree from the University of Vermont. In May, Dr. George A. Zentmyer started a project in chemotherapy in connection with Dutch elm disease. Dr. Zentmyer came from California and was recently connected with the Division of Forest Pathology at San Francisco.

One of the services regulated by the Entomology Department is that of bee inspection. Following the retirement of Mr. H. W. Coley last March, Mr. Roy Stadel of Southington was made bee inspector, covering the four southern counties of Connecticut.

Honors

Two awards of the All-American Vegetable Selections of the Seed Trade Association of North America came to Station entries in September, 1940. *Yankee Hybrid*, a new squash developed here and ready for commercial introduction, was given a bronze medal on the basis of earliness in sections of the country where it was tried. It is also more prolific than standard squash in the high-priced early season in this State. *Marcross* is one of a trio of first early, quality sweet corn hybrids introduced in the past few years. During the year, 177,000 pounds of seed of this hybrid were produced for sale in the United States.

Meetings and Field Day

Although a number of small meetings were held at the Station in 1940, there was no assembly room for the larger groups. This is one of the handicaps that will be remedied by the opening of the new building.

On August 21 the Station held its Annual Field Day at the farm at Mount Carmel. More than 650 persons came to see the exhibits

in field and barn and to hear Director W. H. Martin of the New Jersey Experiment Station speak. Dr. Martin's subject was "North-eastern Agriculture and the Present Emergency."

Publications

Between July, 1939 and July, 1940, the Station published nine bulletins and six circulars besides a number of mimeographed reports. The titles of these, together with journal papers by members of the staff, are listed after the section reviewing department work. In that place also will be found a list of active projects in 1940-41.

Progress of the Station's Work

ANALYTICAL CHEMISTRY

DR. E. M. BAILEY, in charge

THE Department of Analytical Chemistry is chiefly concerned with examinations of fertilizers, feeding stuffs, foods, drugs and insecticides as required by State statutes relating to these materials. It is also charged with the checking and certification of glassware used in testing milk and cream by the Babcock method; and with the checking and certification of thermometers used in the control of the pasteurization process in milk plants. Except in the case of fertilizers, enforcement of the statutes concerned is the responsibility of the Dairy and Food Commissioner; but this department collaborates with him in the formulation of rules and regulations for carrying out the provisions of the several statutes. The department also does a large amount of analytical work for other State agencies, notably the Storrs Experiment Station, the Commissioner on Domestic Animals, the State Supervisor of Purchases; and some for other departments of the Station.

Foods and Drugs

The legislature of 1939 passed a Food, Drug and Cosmetic Act superseding the Food and Drugs Act which had been in force since 1907. The new statute in its essential provisions is identical with the federal act of the same name which was approved by the Congress in 1938.

The scope of the new act is broader than the old in that it includes cosmetic preparations, drugs that are used in the diagnosis of disease as well as those used in treatment, drugs that are included in the Homeopathic Pharmacopoeia, weight-reducing preparations, and mechanical devices that are designed or intended to affect the structure or any function of the body. The provisions relating to adulteration have been amplified; and the misbranding provisions require that labelling shall be more informative to the purchaser.

The Dairy and Food Commissioner is responsible for the enforcement of the act and largely also for its administrative features. The Director of this Station is jointly responsible with him for rules and regulations for carrying out the provisions of the statute. The sampling of products is under the authority of the Commissioner and he is authorized to call upon this Station and the laboratories of the State Board of Health for such technical and scientific service as he may require.

The latest report, Bulletin 438, summarizes examinations of over 1,400 samples. About 5 percent of the foods, and about 8 percent of the drugs examined were classed as adulterated, below standard or questionable. Of interest to dietitians are analyses of 71 samples of cereal breakfast foods. These analyses revise similar data given in Bulletin 373, issued in 1935. A five-year summary of vitamin D

milk examinations shows that 318 samples have been assayed and that the vitamin D unitage claimed has been fully or substantially met in 90 percent of the samples tested. The nature of the biological test employed is such that a large number of samples cannot be examined, but the effectiveness of the control lies in the fact that samples are picked up from the market supply at any time, and continuously, throughout the year. Other items of foods examined include carbonated beverages, edible fats and oils, flavoring extracts, meat products and spray residue on apples. Among drugs, proprietary remedies of the sedative type and turpentine are included.

Fertilizers

Inspections and analyses of commercial fertilizers have been functions of the Station since its foundation in 1875. At that time the work was done under provisions of the statutes which required manufacturers to label every package of commercial manure, weighing 50 pounds or more and selling at more than one cent per pound, except products made from fish and sold as such. The label was required to show the net weight, the name of the manufacturer and the analyses of the article. In practice manufacturers signed an agreement with the Station to sell their wares on a guaranteed analysis, verification of such analysis being left to the Station. This is the "state what you sell and sell what you state" policy and it is still a basic principle in regulatory work.

The first report of the Station (1876) shows that 22 local firms and 16 outside the State signed agreements with the Station to sell fertilizers according to the law and regulations; and that 162 samples were analyzed and discussed.

Out of this agreement plan of operation grew the present-day registration requirement whereby fertilizer manufacturers file with the Station certified statements as to the brands of fertilizer they will offer for sale in the State and the guaranteed analysis of the same in terms of minimum percentages of plant food elements. For the past year 344 firms registered brands of mixed fertilizers and raw materials. A total of 364 official samples were examined, representing 61,000 tons sold in the State. This is exclusive of any tonnage distributed in the State by government agencies, which does not come within the scope of Station control. About half of this amount, 30,000 tons, represents commercial mixtures; and about 10,000 tons of cottonseed meal and other vegetable meals are included.

Feeding Stuffs

There was no legislation in this State relating exclusively to the control of feeding stuffs until 1899, although under the general food law enacted four years earlier the definition of "food" included articles of food and drink for horses and cattle as well as for man. However, the Station gave attention to the substance and quality of feeds and fodder materials almost from the beginning of its activities, and analyses and discussion of such were included in published reports.

No registration of commercial feeding stuffs was required by statute until 1925. Prior to that time about 200 samples were examined each year. After registration was required, the work was greatly increased. Currently some 200 firms register a thousand or more brands of concentrated feeds for sale in the State. In the past year 849 official samples of commercial feeds and 45 samples of vitamin D carriers were examined. Ninety-six percent of the guaranties made for the feeds were substantially met or exceeded; and of the vitamin D carriers, 31 met or exceeded the unitages of vitamin D claimed for them, 11 were passed as substantially equal to guaranties and only 3 were definitely below standard. Microscopic examination of mixed feeds revealed no substantial variations from the declared ingredients and no significant contamination with weed seeds.

Feeders of stock and poultry often submit specimens of feed and/or the viscera of animals for examination to determine the cause of illness or mortality. Our examination has never warranted conclusions that the commercial feeds being used were responsible for the trouble complained of, except in one instance some years ago, in which the sample submitted contained a considerable contamination of corn cockle. The examination of animal organs, however, not infrequently reveals poisonous substances that suggest possible or probable cause. A discussion of this feature, with a list of some of the poisons found, is included in Bulletin 436.

Altogether, the official inspection of commercial feeds and the examination of other fodder materials, including samples analyzed for the Storrs Station, totals 1840 samples for the year.

Insecticides

Commercial insecticides and fungicides are examined each year and reports issued at intervals. A comprehensive compilation of analytical data on these materials was issued in 1937, Bulletin 398; and Circular 136 was issued last year.

Babcock Glassware, Etc.

During the year, 3,189 pieces of glassware, Babcock test bottles, pipettes and thermometers were checked as to accuracy of graduation.

Miscellaneous

The department has collaborated with the Dairy and Food Commissioner in the preparation of rules and regulations for carrying out the provisions of the recently enacted Food, Drug and Cosmetic law; with the Milk Regulation Board on matters relating to the control of production of vitamin D milk; and with the Association of Official Agricultural Chemists in the preparation of the fifth edition of "Methods of Analysis" published by that association. This text is important to all technical and scientific workers concerned with official control of fertilizer, feeding stuffs, foods, drugs, insecticides and other materials that are subject to public control measures, because it is their official guide and reference on analytical procedure. Representing this association, the Chemist-in-charge has collaborated with the American Public Health Association in the preparation of re-

visions of "Standard Methods for the Examination of Dairy Products" published by that association, to the end that the method of these two associations may be in unity so far as methods of their common interest are concerned.

The Station's interest in the Association of Official Agricultural Chemists is traditional because when this association was founded in 1884, Professor S. W. Johnson, then Director of this Station, was chosen as its first president; and Dr. E. H. Jenkins, his colleague, and later Station Director, was one of the founders. The Station, through this department, has been actively associated with the affairs of that organization continuously since that time.

BIOCHEMISTRY

DR. H. B. VICKERY, in charge

THE growth of a plant is a complex process that involves the acquisition of compounds that contain carbon, hydrogen, nitrogen and oxygen from the soil and from the air, and the transformation of these compounds into the substances needed for the enlargement of the cells and the production of new cells of various types. In addition, the plant requires a supply of inorganic substances that contain a wide variety of chemical elements. Among the most important of these are potassium, calcium, magnesium, phosphorus, iron and even such less well-known elements as boron. The problem of the plant biochemist is to determine, from an examination of the tissues of the plant, the kinds of chemical reactions that occur in the cells whereby the plant transforms the relatively simple compounds that form its food into the extremely complex organic compounds found in the growing or mature organs.

Although we are still in ignorance of the nature of the initial chemical changes that take place when the carbon dioxide of the air first finds its way into the stomata of the leaf, or the nitrate ions of the soil solution are absorbed by the root-hairs, some success has attended efforts to understand certain of the subsequent reactions. The final stages which have to do with the synthesis of the more complex of the cell constituents, such as the proteins and the carbohydrates and fats are, however, still largely incomprehensible. Accordingly plant biochemistry is concerned chiefly with the problem of intermediary metabolism, that is, with the nature of the organic substances that represent more or less well-defined stages in the general processes of chemical synthesis and decomposition that normally occur in the tissues. If the mode of synthesis or decomposition can be ascertained, the nature of the reacting substances determined, and the phenomena, such as enzyme catalysis, which accompany the reactions defined, progress in the understanding of plant growth will have been made.

Tobacco Plant Studies

The results of an examination of the composition of a series of tobacco plants grown under otherwise constant conditions, but with

progressive alteration of the relative proportion of the nitrogen supplied as nitrate and as ammonia, were briefly mentioned in last year's report. The data have now been completed and are discussed in Bulletin 442, the eighth in our series on the chemistry of this plant. The chief effect of the substitution of ammonia for nitrate in the culture solution administered is a profound diminution in the amount of organic acids the leaves contain. Ordinary tobacco leaves, grown in the field with most of the nitrogen available to the plant as nitrate, contain from 10 to 20 percent or even more of their dry weight as organic acids, most of which consists of malic, oxalic, and citric acid. When grown in a culture solution that provides 60 percent of the nitrogen supply as ammonia, the plants are not different in size or appearance but the leaves may contain as little as 5 percent of organic acids. Most of the change is due to the almost complete disappearance of malic and citric acids. This profound alteration of the composition presents chemical and physiological problems that are still unsolved but it seems clear that the organic acids are in some way concerned with the assimilation of nitrogen by the plant.

Isotopic Nitrogen Studies

We have completed examination of the tissues of a tobacco plant grown for three days in a culture solution containing half of its nitrogen in the form of ammonia, a small proportion of which consisted of the rare isotopic nitrogen of atomic weight 15. This form of nitrogen can be recognized and the quantity present determined by means of the mass spectrophotograph. The analyses were made by Professor Rudolf Schoenheimer of Columbia University. It has been found that nitrogen taken up as ammonia by the roots is promptly conveyed to all parts of the plant and is converted into the nitrogen of amino acids, amides, and especially proteins. The quantity of the isotope in the proteins was greater than that to be expected from growth alone during the experimental period and it was possible to draw the conclusion that the proteins of the cells undergo continuous chemical reactions with the simpler and more soluble nitrogenous components. Thus the cell proteins, instead of being inactive substances which behave as a sort of reserve or storehouse for nitrogen as has long been held, are, on the contrary, highly reactive substances which play an important part in the chemical changes that take place in the cells of plants. The observations correspond in many details with previous observations on animal tissues made by Schoenheimer and his associates and are leading to a new conception of the role of proteins in cell metabolism in both animals and plants.

Organic Acid Studies

Methods to determine malic, citric, and oxalic acids in plant tissues have been developed here in recent years. It has also been found possible to determine the total organic acidity by means of a titration method in which use is made of the glass electrode. When the sum of the three known acids is deducted from the total acidity, a deficit is almost always found that has been reported as "unknown organic acids". The proportion of unknown acids varies widely in

different plants and in the same plant under different conditions of growth. For example, tobacco leaves grown in the field usually contain about a fifth of their organic acids as these unknown substances. This relative proportion may be greatly increased if plants are grown with ammonia as the chief source of nitrogen. In other plants, such as maize, the unknown acids may normally make up half or more of the total acids. It is clearly desirable to account for as much of this unknown fraction as possible and considerable attention has been given to the problems of identifying and determining some of the acids in it. Succinic acid has been found to be present, although in small amounts, in a wide series of tissues examined and a new method has been developed to identify and determine this substance in plants.

At the request of the editors of *Annual Review of Biochemistry*, a review of the progress of research on the organic acids of plants during the past two years has been prepared and has appeared in Volume IX of this publication.

Amino Acid and Protein Studies

A new method to determine glutamine has been developed for application to special cases in which the amount of glutamine is small and it is desired to obtain a greater degree of certainty of the identity of the unstable amide than can be secured from the hydrolytic method usually employed. The method depends on the transformation of glutamine into pyrrolidone carboxylic acid when the amide is hydrolyzed with boiling water. This acid can be quantitatively extracted with organic solvents and the amount is calculated from the increase in amino nitrogen when the extract is hydrolyzed with acid.

A new method to determine arginine in proteins was mentioned last year. This has now been applied to a series of proteins prepared from seeds of plants of the family Cucurbitaceae. The protein from watermelon seed has been found, in confirmation of results secured by workers in India, to yield more arginine than edestin which has previously been regarded as the richest source of this amino acid among plant proteins.

Edestin from hempseed has long been employed as a standard example of the large group of proteins known as seed globulins. More study was given by Osborne to this protein than to any other, and in recent years it has assumed ever increasing importance. The passage of the Federal Marihuana Law has placed severe restrictions on trade in hempseed unless the seed is devitalized. The commercial process of devitalization by heat so changes the properties of the protein that it can no longer be extracted from the seed and, accordingly, edestin has now become difficult to obtain. Study has therefore been made of the possibility that some other protein may be used in its place. The properties of the proteins of cucurbit seeds are such as to suggest that one of them may be found to be a satisfactory substitute and several have accordingly been prepared and analyzed for arginine and other amino acids. Among these, the protein of the seed of the common pumpkin seems to possess suitable chemical and physical properties. Studies of its nutritive properties, in comparison with edestin, are to be made.

A general review of the amino acids that have been isolated from proteins and of the quantitative relations between these as they affect theoretical views of the constitution of the protein molecule was prepared and presented at a *Symposium on Proteins* held at the New York Academy of Sciences.

Nutrition Studies

Progress has been made in various phases of the study of calcium and phosphorus metabolism.

Several years ago an increased rate of growth of the young rats of the colony was observed and a study of the food requirements of these animals was undertaken. Considerable attention was given to the inorganic salts in the food, and a new salt mixture was devised to replace that of Osborne and Mendel which had been in use for many years. The Osborne and Mendel salt mixture is rather hard to prepare, and the rate of growth of "rapid growth" rats is somewhat depressed when enough of the mixture is fed to give satisfactory calcification. In the preparation of the new salt mixture, the aim was to make it equivalent to the old from the standpoint of bone formation, without causing any decrease in the rate of growth.

From time to time after the introduction of salt mixture 351 in 1937, comparisons have been made to detect any changes in the response of later generations of rapidly growing rats to this and to the old mixture. During the period from 1934 to 1937, a bone ash of 58-59 percent was usually obtained from the femurs of a 200-gram male rat with the use of food containing either 4 percent of Osborne and Mendel salts or 2 percent 351 salts. Recently the figure has been much lower for each salt mixture. There has been a decrease of about 10 percent in the amount of food consumed for a given amount of gain in weight, and this has involved a lowered intake of calcium and phosphorus. However, it does not seem likely that the lowered food intake is the only cause of the lowered ash, because in pilot experiments in which the growth rate was decreased by the use of a smaller amount of yeast, the food intake was essentially the same as in the earlier experiments, but the percentage of ash in the bones was still subnormal.

The general problem of the utilization of calcium for green leaves that contain oxalates has been continued with the use of mature as well as young rats. There seems to be very little disturbance of bone calcification in the older rat when oxalates are red, and the relation of age to the interference of ingested oxalates in calcium metabolism is being examined.

The study of the effect of citrates on the healing of rachitic bones has been continued, although the need for animals for routine assays of vitamin D milk has made it necessary to limit this work. The reports of other workers that the addition of salts of citric acid to rachitogenic diets will aid the healing of the rachitic lesion have been definitely confirmed and experiments are in progress to determine the mechanism of this healing.

An investigation of the nutritive value of certain globulins from cucurbit seeds is being undertaken. Preliminary experiments indicate that the globulin from watermelon seed is probably the equal of edestin, the globulin from hempseed which has been used extensively in the past.

ENTOMOLOGY

DR. R. B. FRIEND, in charge

THE Entomology Department is concerned with research on insect pests, regulatory and control work, and service to the citizens of the State on problems involving insects and other injurious animals. Although the ultimate aim is the direct solution of economic problems, it is necessary to carry on research on the biological principles involved in the relations of insects to human welfare. The department collaborates with federal agencies working in the State, and a few of the projects are cooperative.

INSECT SURVEY OF CONNECTICUT

The initial step in the solution of any insect problem is the identification of the species involved. To aid in this the Station maintains a collection of Connecticut insects and other arthropods, and the staff carries on a certain amount of taxonomic work. The collection now contains about 7,500 species and is being augmented continuously. Some of the more important recent additions have been a number of Lepidoptera and parasitic Hymenoptera. The Lepidoptera, between 3,000 and 4,000 specimens, are the gift of Mr. Harry L. Johnson of South Meriden, who has frequently donated specimens to the collection in past years.

The publication of the *Diptera of Connecticut* has been unavoidably delayed, but the first fascicle should be published by the State Geological and Natural History Survey in the near future. Dr. Garman, a member of the department staff, has published Station Bulletin 431 on the *Tetranychidae of Connecticut*, a family of mites containing such economically important species as the European red mite, the spruce mite, the cyclamen mite, etc.

PESTS OF VEGETABLE CROPS

European Corn Borer

On the basis of plot experiments reported previously, a large-scale field experiment for control of the European corn borer in early sweet corn was conducted in 1940. Two plots, .8-acre each, in a heavily infested commercial field of Market Hybrid sweet corn in New Haven were treated with insecticides according to standard schedule, one with a derris dust containing 1 percent rotenone, and the other with a dual-fixed nicotine dust containing 3.75 percent nicotine. The ears from the derris plot were 50 percent borer-free, and the untreated plot produced 28 percent borer-free ears. The operation was very profitable, as shown by receipts from sales on the farmers' market and cost of treatment. The total sales of all ears from the derris plot brought \$295.24 for 9,323 ears, and

from the dual-fixed nicotine plot \$281.63 for 8,291 ears. The untreated plot produced \$88 worth of borer-free corn on 0.8 acre, but infested untreated corn was not salable. The cost of treatment was \$34 for dual-fixed nicotine and \$22 for derris dust. In spite of the lower cost of derris dust, dual-fixed nicotine was preferred because of the high percentage of borer-free ears. The differences in yield between plots were due to factors other than control of the European corn borer.

In experimental plots, the effect of different insecticides and the time and method of application were investigated. These tests confirmed the greater effectiveness of dual-fixed nicotine as compared to derris dust. An impregnated derris dust (*Agicide*) and a similarly prepared pyrethrum dust (*Dry Pyrocide*) were about as effective as an ordinary derris dust. The application of dust in the evening was at least as effective as that early in the morning when the plants were wet with dew. The standard schedule of four treatments, applied at intervals of five days, was more effective than three treatments at weekly intervals. The use of a power duster resulted in somewhat less effective control than when careful hand applications were made. However, machine applications were satisfactory.

Cabbage Worms

Both the imported cabbage worm (*Pieris rapae* Linn.) and the looper (*Autographa brassicae* Riley) were abundant and destructive to late cabbage in 1940. Three dust materials were used in preliminary tests to control larvae of these species: (1) a derris dust containing 1 percent rotenone made from pure ground derris root and an inert carrier; (2) a proprietary impregnated derris dust made by adding a solution of derris extract to an inert carrier (*Agicide*, labeled 1 percent active ingredients) and (3) a proprietary impregnated pyrethrum dust, (*Dry Pyrocide*). Applications were made to late cabbage on August 5 and 15 and September 4 and 16. The treatments reduced the damage considerably but did not kill all of the looper larvae. The average weight of the dusted heads was 3 pounds, and of the untreated heads 1.75 pounds. The treatment given was preventive, that is, dusts were applied whether larvae were seen or not.

Cabbage Maggot

The use of calomel-gypsum dust for control of the cabbage maggot, (*Hylemyia brassicae* Bouché) has been reasonably effective in actual practice. However, many growers have failed to obtain the best control because of improper timing of applications. Since calomel remains effective in the soil for comparatively long periods, treatment at planting time has been tested during the last three years. These experiments showed that an application of 4 percent calomel dust (with clay, talc, or gypsum as a carrier), made around the stems of newly set cabbage plants in April, protected them from cabbage maggots. The advantages of this method are (1) that the insecticide

is applied before the eggs are deposited and timing is no longer a problem, and (2) that the treatment can be completed at planting time, thus avoiding further work later.

Wireworm Injury to Potatoes

During the past harvest season each of the 17 potato fields in Tolland County examined for wireworm damage in 1939 were revisited. In six cases where the fields were again in potatoes, estimates indicated less injury than was noted during the 1939 season. In cooperation with the Soils Department of the Storrs Station, the extent of wireworm injury was also estimated in each of 60 potato plots devoted to the study of rotation with green manure crops. Not much significant information can be gained in a single year, but it is believed that observations covering a period of years will demonstrate for this region the types of green manure crops which favor or inhibit an increase in the wireworm populations.

Control experiments were conducted in a potato field in Manchester, in which wireworm injury had been severe in previous years, with poison bait in the form of potato fragments treated with paris green, thallium sulfate, or tartar emetic; and with chloropicrin injected into corn rows in the expectation of killing the wireworms that might have been attracted to the sprouting corn. Results were inconclusive because no part of the field, even untreated areas, showed severe wireworm injury to potato tubers.

Onion Thrips

The onion thrips was not present in great abundance during the past season, presumably because of cool, moist weather conditions in early summer. Set onions planted at Mount Carmel matured with no appreciable injury. Seed onions were more heavily infested, and three insecticides were tested on these. Two antimony compounds showed killing properties superior to a rotenone compound, and onion foliage sprayed with them retained a far better appearance than that left untreated or treated with the rotenone. This appearance, however, was not reflected in significantly higher yields. A heavy infection of pink root may have obscured the favorable effect of the antimony treatment, and perhaps larger differences in yield would have been observed if the thrips population had been greater. Further tests with several new antimony compounds are planned for next year.

Squash Vine Borer

Vines of Table Queen and Delicious varieties of squash treated for protection against the vine borer with rotenone dust, dual-fixed nicotine dust, or lead arsenate spray did not produce significantly higher yields than vines left untreated. The population of the vine borer seemed to be as large as normal, and the favorable yield of the untreated squash appeared to be attributable to the planting of the squash at an earlier date than is customary. It is believed that by the time the vine borer appeared, the squash vines were large enough to

withstand most of the damage caused by the feeding of the insect. To check this observation, a series of plantings of winter squash at different dates will be made in 1941, and the resistance to borer injury will be observed.

INSECT PESTS OF FRUITS

The Oriental Fruit Moth and Its Parasites

Although the control of this major pest of peaches still presents some difficulties, a certain amount of progress toward a solution of the problem has been made. The work involves the use of parasites and the development of suitable insecticides.

The distribution of parasites in cooperation with the Connecticut Pomological Society was continued as usual. During the summer approximately 60,000 *Macrocentrus* larval parasites were placed in Connecticut orchards on orders of the various peach growers in the State. For the purpose of determining larval and egg parasitism, 166 collections of tips infested with fruit moth larvae and 111 collections of eggs were made, and corrugated paper bands for the collection of larvae were placed on the trees in 22 orchards. Fruit from 20 orchards was examined at harvest to determine fruit moth infestation. In 12 of these the infestation was too low to be considered serious. Investigations show consistently that a high parasitism of the larvae in the twigs early in the season is correlated with a low fruit infestation at harvest time.

Control of the fruit moth on peaches by using insecticides has never been satisfactory for several reasons. During the past season experiments using xanthone (Genecide) were made in three orchards. The consistent results of these field tests indicated that the material possesses considerable insecticidal action when applied four times in August and September. Laboratory tests confirmed the results, and experiments will be continued.

Orchard Insecticide Investigations

The effectiveness of three so-called "dinitro" products, 2,4 dinitro-phenol, 3,5 dinitro-o-cresol, and dinitro-cyclo-hexyl-phenol in killing aphid and red mite eggs has been compared. None of these materials was satisfactory when used on red mite eggs, but field experiments with both 2,4 dinitro-phenol and 3,5 dinitro-o-cresol gave moderately good aphid control. The material was first placed in solution with monoethanolamine and then enough oleic acid added to bring it to the neutral point, making a soapy mixture. This mixture can be used to emulsify oils if it is desired to include them.

For some purposes a substitute for lead arsenate, which may leave a poisonous residue on fruit under certain conditions, is desirable. During the past season field tests using 0.5 percent oil-rotenone preparations were conducted in two orchards for control of the apple maggot, which requires late applications of insecticides. Considerable success was attained. Inasmuch as rotenone breaks down and loses its toxic properties in the presence of sunlight and air, different carriers of this compound were tested with the aim of im-

proving the lasting qualities under field conditions. Laboratory experiments in which a sun lamp was used as a source of light indicated that red clays are superior to pyrophyllite in protecting the rotenone from breakdown and loss of toxicity.

One of the problems in spraying of fruit trees is to make the insecticide adhere to the foliage well and at the same time cause no injury to the tree. This problem of suitable adhesives has been studied in cooperation with the Department of Analytical Chemistry, and plot tests have yielded valuable information. It has been found that by using materials which gave a heavy deposit of arsenic, good insect control can be secured with fewer sprays. A mixture similar to the so-called "dynamite" sprays, but so prepared that no foliage injury results from its use, adhered well and gave good protection against insects at the same time, apparently allowing the fruit to become larger than that on similar trees sprayed with the "dynamite" lead arsenate combination. This mixture contains a special aluminum acetate, benzoic acid, and white oil in addition to lead arsenate, the oil being emulsified in the aluminum acetate-benzoic acid mixture. It gives a spot type cover which adheres tenaciously to the foliage.

The Japanese Beetle

This insect is increasing in abundance in the State and will probably continue to do so for the next few years. The adults eat the foliage and early ripening fruits of orchard trees, the foliage of shade trees and ornamental shrubs, the flowers and leaves of garden annuals and perennials, and injure some vegetable crops. In certain towns they have already become a serious pest. In 1940 defoliation of trees and shrubs was much more conspicuous than during any previous season, particularly in Greenwich, Bridgeport, New Haven, Hamden, Branford, Hartford, East Hartford, and West Hartford. In an orchard in Greenwich the plum and nectarine crop was lost because of defoliation of the trees, and some loss to the early peach crop due to feeding on fruit was sustained.

Experiments on control by using insecticides were carried out on orchard trees, grapevines, and ornamental trees and shrubs. On peach trees a spray mixture containing derris (4 percent rotenone) and rosin residue emulsion protected the foliage for about five days. This may be used in an emergency, but it would be very expensive if used throughout the flight period of beetles because of the necessity of repeated applications. On ornamental trees and shrubs this same mixture, applied six times at seven-day intervals, gave good results, but the protection to the foliage would have been better if the applications had been made every five days. A mixture of lead arsenate, soy bean oil and flour, sprayed on ornamental trees and shrubs once, protected the treated foliage for the entire season. The rainfall was not sufficient to wash off the insecticide. New growth, developing after the first application, must be sprayed in order to be protected. Two applications of a mixture containing tetramethyl thiuram disulfide and phenothiazine were made to grapes. The new growth which developed after the applications were made and some of the sprayed foliage were eaten by the end of the season.

Injury by Japanese beetle grubs to turf occurred in several towns in the State but was not so extensive in the fall of 1940 as anticipated. The grubs were late in developing due to the late emergence of adults earlier in the season, and fall rains aided the grass in recovering from the effect of root feeding.

Although the parasites and diseases of the Japanese beetle which have been investigated by this Station affect the adult beetle population indirectly, they directly affect the grubs. Work with parasites and diseases has been mainly in cooperation with the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture. During the past season 25 colonies of the wasp, *Tiphia vernalis*, which parasitizes grubs, have been liberated in the State. Approximately 15 one-acre plots have been established to study the effect of the milky disease of grubs. These plots are being kept under close observation, but it is too early to draw conclusions from them.

INSECT PESTS OF TOBACCO

The work on insect pests of tobacco, carried on in cooperation with the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, is briefly summarized in the section devoted to the work of the Tobacco Substation at Windsor. A more detailed account will appear in the report of the Tobacco Substation.

INSECT PESTS OF SHADE AND FOREST TREES

Gypsy Moth

The work of the gypsy moth control crews consisted of scouting wooded areas and roadsides to determine whether or not the insect was present, destroying eggs, larvae, and pupae when found, spraying infested woodland areas, assisting in the autogiro control operations, and type-mapping forested areas. In addition to the work performed by the State crews, control operations and scouting were carried out by the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture, the Civilian Conservation Corp, and the Works Progress Administration. Details concerning this work are given in the report of the State Entomologist for 1940. In order to obtain a better conception of the gypsy moth infestation in the State and the possibilities of future outbreaks, the gypsy moth crews have started to make type maps of the forested areas. The percentage of food plants favored by the insect and the density of the existing insect population are recorded on the maps. This should aid in determining where and when outbreaks are likely to occur and materially increase the efficiency of future control work.

In order to test on a fairly large scale the efficiency of spraying forested areas with an autogiro, a cooperative experiment with the Federal Bureau of Entomology and Plant Quarantine was carried out in 1940 in the Granby-Simsbury-Canton area. The Federal Bureau furnished the autogiro and part of the personnel and materials. This department did the preliminary ground work and provided a landing field and the rest of the personnel and materials. Much very valuable information was secured, although the complete report is not ready for publication at this time.

Dutch Elm Disease

All Dutch elm disease control and eradication work in Connecticut during 1940 has been carried on by the U. S. Department of Agriculture, with the exception of occasional assistance by this Station in securing permission for destroying certain elm wood on private property.

This disease has continued to spread in Connecticut, and infected trees have been discovered in 1940 in 17 new towns throughout Litchfield, Fairfield and New Haven counties, and one isolated diseased elm was found in Preston, New London County. The entire area of infection was scouted for disease symptoms with efforts intensified in the border zone. In addition the roadside elms were inspected throughout the rest of the State where the disease had never been found. This year 378 cases of Dutch elm disease were confirmed, distributed among 44 towns. In 1939 the total was 402 and in 1938, 535. No recurrence of disease was reported from five towns where infected trees had previously been found.

A large part of the work of the U. S. Department of Agriculture consists of removal and destruction of elm bark beetle breeding wood. Much of this material which developed within the zone of infection from the ice storm of March, 1940, has been destroyed. This work is systematically carried out each year and is recognized as one of the most important control measures.

Elm Bark Beetles

The Dutch elm disease is transmitted to healthy elms by bark beetles, and certain aspects of the bark beetle problem are being investigated. Experiments with various chemicals indicate that at present no spray tested here can be recommended to wholly prevent twig-crotch feeding by elm bark beetles, although certain sprays did cause a significant decrease in bark beetle attack. Other tests have demonstrated that liquid coal-tar creosote, applied to elm logs with a hand sprayer or brush, completely prevents bark beetle breeding. Several other chemicals tested were not satisfactory for this purpose. A study of the dispersion and feeding of the smaller European elm bark beetle, the effect of attractive breeding material, and the effect of pruning elms on subsequent attack is in progress. Certain insects associated with elm twig-crotch injuries have been noted and reported. A detailed study is being made of the effects of cold on the survival of larvae of the smaller European elm bark beetle.

European Pine Shoot Moth and White Pine Weevil

The seasonal work on these two forest pests is primarily a study of population fluctuations, and the related injury to the trees, over a period of years. This is being continued in plantations at North Guilford and Rainbow. The usual examination of red pine plantations in the northern part of Connecticut, which is annually undertaken in order to assist the C.C.C. pine shoot moth control operations in this region, was carried out as usual. The W.P.A. pine shoot moth project has been terminated.

PESTS OF LAWNS AND GRASSLANDS

Scarabaeid Larvae

Investigations of the control of the various scarabaeid larvae are continuing. These studies include the effect of certain fertilizers upon the toxicity of lead arsenate, moisture relation to larval damage, population studies in relation to damage and insecticidal tests.

The work with the parasites and diseases of Japanese beetle larvae has been reported under *Insect Pests of Fruits*.

Chinch Bug

Experiments were conducted in 1939 and 1940, testing rotenone dusts of 0.5 percent and 1.0 percent concentrations, and tobacco dusts containing 0.5 percent and 1.0 percent nicotine. Tobacco dust containing 0.5 percent nicotine has been found to be ineffective while the other dusts are very efficient. However, it has been determined that the insect population, density of the grass, temperature and rainfall influence the results. Dusts applied by a hand-distributing machine do not always penetrate thick grass satisfactorily and, as they kill by contact, are somewhat inefficient. The chinch bugs are very active at high summer temperatures, and applications of dusts made under such conditions give good results. Heavy rainfall occurring within a few hours after the insecticide is applied is likely to destroy the toxicity of the dust. It is usually necessary to make a second application of dust on turf which is heavily populated by the chinch bug and additional spot treatments of persisting localized infestations.

OTHER INSECT STUDIES

Black Vine Weevil, *Brachyrhinus sulcatus*

Sporadic infestations of the black vine weevil occur in nursery blocks of *Taxus* and, in Connecticut, less often in strawberry beds. The adult weevils are parthenogenetic, wingless and feed upon the foliage of *Taxus*, hemlock, and other nursery plants. The larvae live in the soil and feed upon the roots and crown of the plants, oftentimes killing them.

Experiments were conducted in a nursery this past summer, using lead arsenate sprays, a commercial bait known as "Go-West" (a mixture of apple pomace and sodium fluosilicate), and bran baits containing calcium arsenate or sodium fluosilicate for the control of the adult. Lead arsenate was placed in the soil in an attempt to kill the larvae. The lead arsenate spray and "Go-West" treated blocks gave the best results. The soil treatment must be checked again in the spring before it can be compared with the others.

The Control of Termites

Requests for examination of buildings for the presence of termites were not as numerous in 1940 as they had been during the preceding four years. Observations indicate, however, that termites are just as abundant as in the past and are causing fully as much damage as they did four or five years ago. Examination of infested buildings in which

no control measures were carried out showed continuing termite damage. Experimental soil treatments have failed to stop termite attacks on two infested buildings, and further treatment has been given.

INSPECTION OF NURSERIES, APIARIES AND IMPORTED STOCK

Nursery Inspection

During the summer, 382 Connecticut nurseries with an area of 4,737 acres were inspected in compliance with Section 2136 of the General Statutes. Some of these were inspected more than once to check on the eradication of pests. Altogether 100 different insect pests and 56 plant diseases were found, but most of them were of no economic importance. In addition six shipments of imported rose stocks, consisting of 239,400 plants, were inspected.

Members of the department visited 277 orchards, farms, gardens and houses to give advice about the control of insect pests.

Apiary Inspection

In 1940 the two apiary inspectors visited 143 of the 169 towns in Connecticut and inspected 1,719 apiaries containing 8,552 colonies. They found 366 colonies in 161 apiaries infected with American foul brood. All the infected colonies were treated or destroyed. The average number of colonies per apiary was 4.9 and the average cost of inspection was approximately \$1.33 per apiary and \$.268 per colony.

RODENT CONTROL

The Fish and Wildlife Service, United States Department of the Interior, has continued its cooperation with The Connecticut Agricultural Experiment Station on a part-time basis during the year 1940. Research projects have been continued on the ecology and control of Pine Mice (*Pitymys pinetorum*); the rate of fluctuation or cyclic tendency of Meadow Mice (*Microtus pennsylvanicus*); and the development of a rabbit repellent to protect trees and shrubs from damage by rabbits. Valuable data are being obtained which will lead to the control of these rodents.

FORESTRY

W. O. FILLEY, in charge

THE hurricane of September, 1938, continued to affect the work of this department throughout 1940, but a return to normal activities during the coming year is anticipated.

The Rainbow experimental forest has been cleaned up and a fire hazard reduction plan carried out by men from the C.C.C. camp in Hartland. A three-room cabin, built largely of salvaged wood, will serve as headquarters for men working in the forest, and for the patrol that will watch the tract during the dry months of spring and fall. No fires have occurred since 1938.

Outlets for Native Wood

A number of agencies have been cooperating in efforts to find new uses for low-grade forest products in Connecticut. Although there is plenty of native wood, the constant demand for posts and

poles has been supplied by material brought from other states. The competition must be met by developing a preservative treatment that will make our available woods more durable.

The problem of the Forestry Department is to find the best materials and methods for treating native species, and to measure the relative durability of these species when treated.

With this object many tests with zinc chloride were made in 1940. The investigation of the quantitative distribution of the preservative in treated posts, carried on cooperatively with the Yale School of Forestry, has been completed. Results are to be presented in a Station bulletin.

In cooperation with the State Highway Department, a survey of highway posts was made during the summer of 1940. Approximately 5,500 guide rail posts, which had been in service from 2 to 12 years, were carefully examined for evidence of deterioration. The species involved were chiefly oak, maple, birch, white cedar, pitch pine and chestnut. The treatments were with creosote applied superficially by brushing, or impregnated by the open-tank method. The three main points brought out by the survey were:

1. Superficial treatments by brushing or dipping in creosote are not satisfactory for posts which cost as much to install as guide rail posts.
2. Posts impregnated by the open-tank method were 98 percent sound after five and one-half years of service.
3. The part of the post above the ground line should receive some kind of preservative treatment. Of some 4,000 posts of oak, maple, birch and pitch pine, in service five to seven years, 25 to 60 percent of the untreated tops showed some decay and 10 percent were marked for removal because of top rot.

As a result of this survey and of other investigations now being made, it is anticipated that there will be a considerable change in policy both in regard to the kinds of wood used and in the specifications for treatment. It is to be hoped that this will result in an increased use of native-grown woods impregnated over their entire length by the open-tank method or by pressure.

In addition to work on wood preservation, the Station has been cooperating in developing better methods of producing charcoal. There is a good market for this material in the State, now largely supplied with by-product charcoal from Pennsylvania and New York. The object of the studies is to devise ways of lowering the cost of production to a point at which local charcoal can be produced in competition with that from out-of-state sources.

The immediate objective in the experiments is to develop a kiln which will require a minimum of attention during coaling and which can be easily moved. Such a burner could be set up in places where wood can be concentrated by sled and the charcoal removed by truck, thus eliminating much handling. The apparatus being tried is of

sheet metal and is patterned after a Swedish kiln. It has only one opening for incoming air and one for outgoing smoke. Rate of burning may be controlled at either opening. On experimental runs to date, the apparatus has required very little attention and there is reason to believe that an automatic control can be devised.

Timber Testing .

During the salvage at Rainbow about 150 logs, comprising some 10 species of wood, were specially sawed to provide material for a series of standard timber tests. These tests are of particular value for two reasons. First, the wood was all artificially grown in plantations; and second, several of the species represented are exotics. No testing data are available on the latter when grown in this country. In cooperation with the Yale School of Forestry, tests were performed on two species, white pine and Norway spruce, during the academic year 1939-1940. The work on the first was completed and the results will be published as a Station bulletin.

Control of White Pine Blister Rust

Blister rust is a disease threatening valuable stands of white pine covering 100,000 acres in the State, that has been practically brought under control. It has been demonstrated that the rust can not spread from pine to pine but requires an intermediate host of the genus *Ribes*: currant and gooseberry bushes. Systematic mapping of the pine stands followed by elimination of *Ribes* within 900 feet of white pine has kept the disease at a minimum.

The usual amount of mapping and eradication was carried on last year under Station direction, using C.C.C. and W.P.A. labor.

In 1941, the control work will be conducted on a maintenance basis. The educational and research activities, and the administration and supervision of field work will be carried by state and federal funds. The field labor will be carried by town and individual co-operative funds. It is estimated that hereafter the cost of maintaining control of the blister rust disease and insuring economic protection to the white pine of the State will average between ten and twenty cents per year for each acre of pine.

Dutch Elm Disease

This project had been under supervision of the Station Forester since its inception in 1932. However, the importance of insects in the spread of the disease makes its control largely an insect problem. On July 1, 1940, the Station Entomologist was placed in charge of the control work as well as research, and the report for the year is included under Entomology.

Distribution of Forest Planting Stock

The Station has continued planting and distributing trees in 1940. During the spring, 565,000 were sent out, of which 208,000 (30 percent) were sold to farmers under the Clarke-McNary Act. About 40 percent of the total was white and red pine, with 35 percent Nor-

way and white spruce, and 8 percent Douglas fir. Increased demand for forest planting stock created by the Soil Conservation Service in the Scantic River area was taken care of during the past year. However, it did not prove practical to supply the needs of the Agricultural Conservation Program, which secured stock outside the State.

PLANT BREEDING

DR. D. F. JONES, in charge

A RECENT survey of the hybrid sweet corn seed produced for sale in the United States in 1941 shows that one-half million pounds is of Connecticut hybrids or of mixed Connecticut and outside parentage. This is approximately enough to plant one-tenth of the sweet corn acreage in the country.

It is the aim of Station plant breeders to develop a productive hybrid for each of the seven different sweet corn seasons: very early, early, early midseason, midseason, late midseason, late and very late. There is a difference of about three days between each of these.

Again in 1940 trials, *Spancross*, *Marcross* and *Carmelcross* were the best in their respective seasons. These were tested not only in Connecticut but rather generally in the corn growing areas of the United States. All three are resistant to bacterial wilt. *Spancross*, a very early sweet corn, is the first to produce an ear of suitable size for market. It should be planted on the earliest soil and well fertilized to make its best growth. *Marcross*, an early variety, is picked about three days later. It produces a very large ear, one that will compete with most of the midseason varieties. The quality is good. *Carmelcross* follows *Marcross* after a three-day interval. It is classed as early midseason in maturity, producing a rather long slender ear of excellent quality. These three hybrids provide a succession of sweet corn up to midseason.

A new midseason sweet corn has been developed and thoroughly tested and will be produced commercially in 1941. This is a cross between Connecticut 23, a Whipple inbred, and Purdue 39. The hybrid matures about three days before Golden Cross Bantam. Several new late varieties are being tested and seed of some of these will be produced commercially in the near future.

The results of the sweet corn trials are tabulated to show the time of ripening, the number and the size of ears of the various lots tested. Recommendations for planting in Connecticut, together with sources of seed, are given and this report is available to those interested.

Squash

The first generation hybrid between Connecticut inbred C10 and Early Prolific Straightneck has been named *Yankee Hybrid*. In September of this year it was awarded a bronze medal in the All-American Selections of the Seed Trade Association of North America.

Two seedsmen have produced this hybrid on a commercial scale and their satisfactory reports indicate that the market production of Yankee Hybrid is possible.

A second discovery in connection with breeding this plant may have far-reaching effects in the production of other vegetable seeds as well as squash. It appears that the second generation hybrid yields as many early and marketable fruits as the first. While seed of the first cross may be expensive to produce, that of the second generation comes at small cost.

In our experiments at Mount Carmel and Windsor, comparison was made between the following plantings of squash: C10, Early Prolific, Yankee Hybrid (offspring of the first two) and seed of Yankee Hybrid, or the F_2 generation. There were no significant differences in early yield or in total yield between the first and second generations. The two hybrids were significantly earlier than Early Prolific and C10 but in total production for the entire season there was no difference between parents and hybrids.

While it is true that ordinarily the second generation does not have the high degree of uniformity that is found in the first generation, in this particular cross the variation of the immature, marketable fruit is negligible. The only, but most important, advantage of the second generation squash over the first is found in the lower cost of seed production. On the basis of these results we are suggesting that the second generation seed could be used for commercial planting. Further trials will show other advantages or disadvantages in the production and use of F_2 seed as compared with the F_1 . It is possible also that in these trials a true breeding variety which is as early as the F_1 and as productive may be selected and fixed.

This discovery may have far-reaching effects in the vegetable seed trade. Heterosis has been recognized in hybrids between inbred lines and varieties of tomatoes, peppers, cucumbers, eggplant and onions, but the prohibitive cost of producing hybrid seed has thus far deterred seedsmen from making use of this stimulus to increase production. Since the second generation squash is as good as the first and can be produced as inexpensively as open pollinated varieties, it would seem that the same results may be had with certain other vegetable plants.

Beets

Color and sweetness are two important factors in beet production. For several years the Station has been investigating the causes of variation with the object of control. Selection for high quality, high pigment and sugar content within inbred lines is being continued as well as studies on the influence of environment, season, soil, nutrition, and storage on these characteristics.

The common belief that beets grown in different seasons and soils have different amounts of pigment has been substantiated by experimentation. The differences have been measured numerically and tabulated and several facts have been noted: (1) The pigment

content of roots may vary as much as 100 percent between two consecutive years or 50 percent between spring and fall. (2) The pigment content can be appreciably changed within the same strain by growing the plants in different nutrient solutions. (3) Different soil types may be responsible for color differences. (4) The pigment in stored beets is lost very rapidly during the first two weeks of storage.

These environmental studies are fundamental for a breeding program on beets.

Other Vegetables

Hybridization and selection of peppers and tomatoes is continued as part of the vegetable breeding program. The most promising selections are being tested and will be released as soon as adequate seed is available. Individual celery plants which were selected in 1939 for solid stalk and disease resistance were isolated in 1940 for seed production. These lines will be tested in 1941.

Breeding for mildew resistance in cucumbers and cantaloupe was postponed in 1940 in anticipation of new breeding stocks which will be available shortly through other institutions.

Strawberries

In the 1940 strawberry trials, the two new Connecticut selections, *Shelton* and *Hebron*, have continued to give promising results. *Shelton* is an attractive berry of even size and shape and keeps its color and firmness for a longer time after picking than the varieties commonly grown here. For that reason it is especially worthy of trial as a market and shipping berry. *Hebron* is an attractive and productive late strawberry. Like all varieties ripening toward the end of the season, it is affected by hot, dry weather. Unless grown on well watered soils or irrigated, it may be unsatisfactory. It is also somewhat susceptible to leaf spot.

Interest is developing in strawberries for freezing. Two new selections have qualities that may make them especially desirable for processing in this way and they are being tested with this purpose in mind.

All new strawberries from Connecticut and elsewhere are grown in replicated trials with the standard varieties. The annual tabulation of time of ripening, yield and characters of plant and fruit are sent to strawberry growers and nurserymen on request.

The results of 15 years experience with strawberries, raspberries and blackberries are brought together in a technical bulletin, 435, that is now available.

GENETIC PRINCIPLES

Growth Changes

By the use of especially favorable material having convenient genetic markers, it has been found that growth changes result from chromosome loss and rearrangement in developing tissues. The material used is the endosperm of the corn seed. The markers are the

aleurone color characters, purple and red; and endosperm composition, sugary and waxy. By the use of these markers it has been shown that changes originating in the nucleus have their visible expression in the cytoplasm and cytoplasmic inclusions. The growth changes are of several types. Some increase the amount of reserve food stored and some reduce this. The final result at maturity is exhibited as outgrowths and depressions that may be paired with color and other changes in the appearance of the seed surface. These findings make possible a study of the interaction of nuclear and cytoplasmic factors and contribute to a better understanding of growth processes.

Investigations have been started which will attempt to study the effects of chromosome rearrangements on plant characters using the long inbred strains of corn that are so uniform in all respects that small changes of a physiological as well as a morphological nature can be detected and measured.

Selection in Backcrossed Lines

By a process of backcrossing and selection, inbred strains of corn can be improved in many respects, notably in color of foliage, stiffness of stalk, and productiveness. In many cases these improved lines, when crossed with other lines, do not give any better results and often are less productive and poorer in other respects. A method of selection in backcrossed lines followed by testing in outcrosses is being carried out in an attempt to improve both the inbred lines themselves and their combining ability.

Gametic Lethals

For several years two gametic lethals, small pollen (sp_1) and lethal ovule (lo_1), have been studied. Both genes are closely linked with the sugary locus and give distorted ratios of $Su:su$. The sp pollen grains rarely function in competition with normal, while lo ovules almost always abort before fertilization. The lo factor is unique in that it has no deleterious effect on the pollen, but causes the death of nearly all the ovules carrying it. Both lo and sp are undetectable cytologically. The order on Chromosome 4 is $Ts_3\ la\ sp\ su\ lo\ de_{16}\ Tu\ gl_3$.

Maternal Inheritance

A maternally inherited white seedling has been found in a cross between two Connecticut field corn inbreds, 680.12c \times 243. The original cross gave a high percentage of white seedlings and a few that were striped, green and white, similar to iojap seedlings. The striped seedlings produced ears that gave varying percentages of white seedlings, regardless of the pollen parent. One ear produced 100 percent white seedlings. When seed from these ears is planted in such a way that the location in the seedling bench corresponds to the position of the seed on the ear, it is seen that part of the ear may produce wholly green seedlings, part wholly white and, the area bordering the green and white, a few striped seedlings. The white seedlings are lethal. Ears from striped plants repeat the performance. They are sectorial chimeras.

Color Variegation

A variegated maize plant induced by treating maize pollen with ultra-violet light has been studied for several generations. (Pollen treatment was made by Dr. L. J. Stadler of the University of Missouri.) It is now definitely established that the *B* factor was changed to a *B^v*. Homozygous stocks of *A B^v Pl* have been obtained and the *B^v* factor is being studied further. Preliminary tests have shown that wholly green or wholly purple sectors in the tassel of a variegated plant give similar results when the pollen from the two different kinds of sectors is applied to green plants. Although a section of the plant may be entirely green or wholly colored, the genetic constitution of those areas is still variegated.

PLANT PATHOLOGY AND BOTANY

DR. J. G. HORSFALL, in charge

IN 1940 the unduly wet and cool weather during May and June gave much greater incidence than usual of apple scab and other early foliage diseases. July and early August were dry but a rainy period late in August brought on severe epiphytotics of late foliage diseases such as tomato and celery blights. Downy mildews were notably infrequent, presumably because of the warm nights.

The diagnosis of diseases on plant specimens, submitted by people of the State, appears to be on the increase. In the course of this work, two new diseases came to light in 1940: a new *Phytophthora* disease of peach seedlings, and what appears to be a new bacterial disease of apple fruits. Preliminary investigations were made in each case and additional research is contemplated.

Dutch Elm Disease

As a result of the season's operations, it appears that we may be on the road to a solution of the Dutch elm disease problem. Laboratory and field investigations indicate that the fungus produces a toxin that causes the tree to wilt, and that several organic chemicals, when injected into the tree, will inactivate this toxin so that wilted trees will recover. It seems probable that the chemicals do not kill the fungus in the tree, but it is likely that additional research will suggest the outlines of a future control program. If such a program becomes feasible, it could be useful chiefly to cities and private owners who wish to preserve decorative trees. Probably it would not be practical in the forest.

Vegetable Diseases

In 1940 the defoliation disease of tomatoes, caused by *Alternaria solani*, developed more rapidly and became more destructive than it had been during the past 10 years. A note published in the *Plant Disease Reporter* suggested that its rapid development may have been associated with the leaching of fertility from the soil by the early summer rains, so that the plants became more susceptible to *Alternaria* attack. Field plot trials indicated that susceptibility to *Alternaria* was decreased by side dressings of nitrate of soda and by defruiting

the plants. If these findings are true they show that susceptibility may well be related to the carbohydrate-nitrogen ratio within the foliage.

Fusarium ripe rot of melons and scab on squash are rare diseases that were found in a few fields in Connecticut in 1940.

Squash foot rot, a rare disease that appeared in 1939, was not found in commercial fields in 1940. Even when diseased seed was planted in an experimental field at Mount Carmel, very little foot rot developed.

Fungicides on Vegetables

Research on tomato defoliation on the Nutile Farm at Montowese developed several striking things with regard to the effect of dosage of sprays: (1) The disease control exhibited by a series of concentrations of yellow cuprous oxide was found to show a linear relation when use was made of the log-probit transformation developed by Dr. C. I. Bliss. This relation had not been shown heretofore in field research. (2) Disease control depends upon the amount of spray applied per acre rather than on the concentration, which means that the control obtained by a low amount of copper can be increased by applying it in a larger quantity of water. (3) It was found that the slope of the log-probit curve was a function of gallonage and that it became flatter as the gallonage was increased. It therefore is plain that the slope of this curve is a function of the completeness of coverage and that in the future fungicide research may be simplified by using this slope as a measure of coverage.

The description of a new laboratory sprayer was published in *Phytopathology* during the year. This sprayer may be used in the preliminary stages of fungicide research. A new laboratory duster is in the process of development in collaboration with the Entomology Department.

Diseases of Ornamentals

There were three unusual developments in the field of diseases of ornamentals. Foliage on fall-planted conifers, laurel and rhododendron was badly wind-scorched during the winter and early spring. Presumably this was because the roots entered the winter in a very dry condition as the result of the late fall drought in October and November of 1939. Consequently, they were unable to supply the foliage with the necessary water to withstand losses during the winter.

The season was also characterized by a severe case of what might be termed "tulip failure". Tulip growers all over the East complained that the crop was very low grade in the spring of 1940. The cause appeared to be *Botrytis* blight which was favored by the wet spring and the fact that the bulbs sown in the dry soil the previous fall were not able to establish as vigorous a root system as normally.

Powdery mildew on roses was aberrant in 1940 in that the hybrid teas and hybrid perpetuals were much more severely infected than the climbing variety, Dorothy Perkins. Usually the reverse of this is true.

The end point appears to have been reached in a six-year search for the practical control of the chrysanthemum leaf nematode. It was demonstrated experimentally and also in a large scale nursery that the treatment of dormant plants at 115° F. for 15 minutes was sufficient to kill the nematodes in the roots. There remain only a few points, such as varietal injury and response, to be solved. Results of these experiments will appear in a Station circular.

Fruit Disease

The Mount Carmel orchard was divided during the year between Entomology and Plant Pathology, the latter half being used for research on new fungicides. A dosage experiment with a sulfur material showed that the sulfur acted on apples like copper on tomatoes and gave a linear relation when the log-probit transformation was applied to the dosage data. This experiment produced another new development which showed that the slope of this line increased as inoculation potential increased. This is the first time that a field measure has been devised to show the relation between the disease producing power of the environment and the disease incidence.

Napthalene acetic acid reduced the drop of McIntosh apple fruits in some tests conducted at Mount Carmel during the year.

Research has continued on that baffling malady of peaches called X-disease. Eradication of choke cherry around orchards has kept the disease below about 10 percent in contrast to a 40 percent increase where choke cherry was not removed. Hot water treatment of peach buds appears to reduce their infectiousness somewhat, but hot water treatment does not inactivate the virus in choke cherry.

NEW ORGANIC FUNGICIDES

This Station is one of the few in the United States which has embarked upon a research program in new organic fungicides. One material developed here is now on the market. It exerts a very striking protective action on lima bean seed and apparently stimulates the growth of the plant. Formerly lima bean seed could not be treated safely with any fungicide. The discovery indicates that organic fungicides will be found specific in their action and that plant pathology may well be headed in the direction of special materials for special purposes.

This aromatic organic compound has been found to exert a protective action on foliage when applied as a spray. It may stimulate plants when applied to seed, but it appears to injure them when applied to foliage. One new organic material (336) as yet unnamed, gave good control of apple scab at Mount Carmel. The foliage sprayed with 336 was much darker green in color than the unsprayed or sulfur-sprayed foliage. Practical growers were very much interested in this phenomenon.

In another investigation of organic materials, 500 compounds were given laboratory tests during the winter. Of these only three showed enough promise to be taken to the field and one of them failed in the field. Of the remaining two, however, one gave very striking control of powdery mildew on roses and cucurbits and may prove to be a new specific for this class of disease. The other one gave excellent black spot control and little or no powdery mildew control. This is further evidence of the specificity of organic compounds.

SEED TESTING

As usual the seed laboratory has tested the germination and purity of seeds sold in Connecticut and thus has done its part to assure the consumers of the State that they are able to purchase quality seed which will perform as the label promises. A total of 263 samples was analyzed for purity and 1,870 were tested for germination.

As time permits some research is being conducted on the problems of seed germination. For example, it has been shown that a pre-germination chilling treatment of beet and chard seed will increase the germination percentage appreciably. It has been found also that the new organic seed treatment, mentioned above, is useful to prevent mold from spreading through a sample from infected seed to its neighbors. The use of this material has simplified some of the routine operations.

STAFF CHANGES

As noted in the introduction, two changes were made in the staff during the fiscal year. Miss Frances Johnson was appointed on March 1 to take over the work on seed testing formerly done by Mrs. E. S. Blakesley. With the resignation of Mrs. Mary Stoddard on November 1, 1940, Miss Johnson will assume her duties as well. Dr. George A. Zentmyer was appointed on April 13 to initiate a new project on the investigation of Dutch elm disease with special attention to chemo-therapy.

SOILS

DR. M. F. MORGAN, in charge

Orchard Soil Studies

DURING the 1939 season, the apple crop in many orchards of the State was severely damaged by the physiological disease known as "internal cork", now generally accepted as an evidence of boron deficiency in the soil. Lots of several hundred pounds of soil were collected from nine such locations during the fall, and were studied through greenhouse pot experiments and laboratory analyses in 1940.

Alfalfa serves as an indicator crop to confirm boron deficiency, since it shows characteristic symptoms, called "alfalfa yellows", when the soil supplies an insufficient amount of this element. The tests indicated that seven of the nine suspected soils were deficient. In

each of these cases the trouble was corrected by application of boron equivalent to 10 pounds of commercial borax per acre. One of the soils not showing boron deficiency in greenhouse trials was from an orchard where the symptoms had been improperly diagnosed, the trouble having been due to *Gymnosporangium germinale*, a type of cedar rust. A laboratory method for measuring available boron, developed at the Wisconsin Agricultural Experiment Station, showed excellent correlation with these results. The boron-deficient soils contained from 0.1 to 0.4 parts of hot water soluble boron per million parts of soil. Soils showing no boron deficiency contained 0.6 and 1.2 parts per million. Ten of twelve soils from apple orchards, collected for nutritional studies in 1936 without reference to boron deficiency, not prevalent in that season, contained more boron than did seven of the nine soils collected in 1939.

In the greenhouse trials, lime treatment caused increased boron deficiency except on a soil that was already well limed in the orchard. The greatest effect of liming in aggravating boron deficiency was on the most acid soil in the trials. None of the other treatments — nitrogen, phosphorus, potassium or magnesium — appeared to affect boron availability. However, as a group, the 1939 soils were in a better condition of fertility with respect to lime, phosphorus and potash than the 1936 soils. Improved orchard soil practices, designed to promote the growth of ladino clover and other soil cover, had been in operation in most of the boron-deficient orchards.

Cumulative Effects of Acid-Reacting Fertilizers

A group of soils that had been under study in the Windsor lysimeters during the five-year period 1934-39 was removed to the greenhouse and cropped to alfalfa during 1940. Previous treatments on these soils had supplied heavy annual applications (200 pounds per acre) of nitrogen in the following forms: nitrate of soda, sulfate of ammonia, urea and cottonseed meal. Sulfate of ammonia was used without correction of acid effect, with lime to produce 50 percent correction of acid effect and with full neutralization of acidity. Urea and cottonseed meal were used both with and without neutralization. These trials had been conducted on two soils, one initially at 5.2 pH and the other initially at 6.0 pH. The acid effect of the sulfate of ammonia, with no lime, brought both soils to such an acid condition that the alfalfa never grew more than an inch in height. Cottonseed meal, without lime, had produced an unfavorable condition for alfalfa that could not be ascribed entirely to the direct acid effect of the material, since urea, without lime, left the soil in a state in which a better, although unsatisfactory, growth was obtained. Theoretically, the urea should have been slightly less acidifying, and this was confirmed by pH tests. However, laboratory analyses showed less *exchangeable* calcium after cottonseed meal, without lime. Lime, with sulfate of ammonia in an amount sufficient to counteract 50 percent of the theoretical acidity, permitted about the same growth as did urea without lime. When the acid-reacting fertilizer materials were fully neutralized with lime, excellent growth of alfalfa resulted, even at 5.2 pH.

Nitrate of soda, a theoretically neutral fertilizer under uncropped, normally leached soil conditions, left the soil in a slightly improved condition for alfalfa. However, much better growth was obtained following the treatments with neutralized, acid-reacting fertilizers. The above trials suggest that, theoretically, neutralized acid-reacting fertilizers tend to improve the soil for the growth of acid-sensitive legumes chiefly through increase in the available calcium supplied in the lime used in the adjustment. However, dolomite, supplying less calcium than a corresponding amount of calcium carbonate used in these trials, is most commonly used in the formulation of neutral commercial mixed fertilizers. Further studies will be conducted to ascertain whether these findings are applicable under such conditions.

A final report of the lysimeter studies involved in the above comparisons of acid-reacting nitrogenous fertilizers, with and without lime adjustment, will be published during 1941.

Cover Crops and Nitrogen Leaching Losses

The cover crops seeded after tobacco in the fall of 1939 were especially effective in conserving nitrogen against late fall and early spring leaching, as shown by lysimeter experiments (Series "C"). Little nitrogen had leached during the growing season of 1939, leaving considerably more available nitrogen than was needed by the tobacco. Approximately 80 pounds of nitrogen per acre was taken up by the very vigorous fall growth of oats and retained in the soil, in excess of that lost by leaching from soil left bare of vegetation from tobacco harvest to spring planting.

New Lysimeter Trials

Thirty-four lysimeter tanks, refilled with soil in 1940, are being utilized for a series of experiments with cottonseed meal, soybean oil meal and uramon, at various rates of treatment and adjustment of acidity. These trials are designated as Series "F" of the Windsor lysimeter experiments, and will be conducted for a 10-year period with complete analyses of drainage waters and crops and soil studies at the conclusion of the decade.

Soil Maintenance and Nitrogen Levels in Vegetable Lands

Results of three series of vegetable crop trials at Windsor, conducted during the 10-year period 1930-39, have been reported in detail in Bulletin 439, "Soil Management for Intensive Vegetable Production on Sandy Connecticut Valley Land". These experiments were replaced in 1940 by a series of plots designed to study nitrogen relationships in soil maintenance by green manures in vegetable cropping systems. Three-year rotations including summer green manure crops, and a rotation including a manured summer cash crop replacing the green manure crop, are being conducted. Millet, with and without nitrogen topdressing, and soybeans are used as green manures. The vegetable crops are produced at both moderate and high levels of nitrogen fertilization.

Tomato Cultural Trials

In 1940, the rotations in the above experiment were in the first year of the cycle on only one-third of the plots. Hence there was an opportunity to conduct a supplementary trial of tomato culture, designed primarily to develop the most suitable experimental technique to be followed in the future, when tomatoes appear in the rotations. Comparisons involved: growing without support at four by four-foot spacing; growing with stakes at four by four-foot spacing; trained to one stem, and trained to two stems; nitrogen at 50 and 100 pounds per acre (the extra nitrogen in the latter case applied after the first fruit clusters are well formed).

The staked tomatoes, trained to one stem, produced somewhat more fruit at the earliest pickings. However, the gross returns for combined early and midseason pickings were greatest with two-stem training, averaging \$393.54 for two-stem staked, \$368.70 for one-stem staked, and \$178.00 for the unstaked plants, per acre. Including the later pickings, the total gross values were as follows: two-stem staked, \$487.74; one-stem staked, \$420.45; unstaked, \$337.00. The extra nitrogen applied during the growing period tended to retard early fruit production and was no significant benefit to total yield or returns. The conditions for nitrogen liberation from the soil, to supplement the 50-pound per acre treatment, were unusually favorable during this first year of the experiment, with no losses by heavy leaching rains.

Potato Rotations

In an experiment conducted in cooperation with the Tobacco Research Department at Windsor, potatoes are grown in alternate years after tobacco, sweet corn, clover and potatoes. Data for three seasons, 1938, 1939 and 1940, are summarized as follows:

		Bushels per acre, U. S. No. 1 grade
Potatoes after tobacco		268 bu.
" " clover		256 "
" " potatoes		253 "
" " sweet corn		252 "

It is plausible to assume that the residual effects from the extra heavy fertilizer treatment used for tobacco have contributed to the above results.

Soil Depletion by Erosion

Connecticut farmers are becoming increasingly conscious of soil erosion. The Scantic River project area, being administered by the Federal Conservation Service, has amply demonstrated the need for improved soil management practices designed to control soil erosion. To provide supplemental information concerning depletion by soil erosion in southern Connecticut, special studies have been initiated in the watersheds of Farm River and Muddy River, in the towns of North Haven, North Branford and Wallingford. Preliminary surveys of the severity of erosion under various conditions of cropping were begun in the fall of 1940. A group of soils from 18 repre-

sentative locations under frequent cultivation, under stabilized grass sod and under woodland, have been collected for detailed study in the laboratory and in greenhouse pot trials, in order to evaluate the degree of fertility depletion resulting from erosion.

Calibration of Soil Tests

Demands for soil testing service have continued at about the same rate as in recent years, 4,000 or more samples, submitted largely in the spring season. The methods developed at this Station have been further improved, and special attention has been given to calibration of soil test ratings on representative soils of known response to treatment for various crops. Soil test results on a series of check soils, reported by 40 different collaborators, have been compiled and carefully compared in an effort toward greater agreement in evaluating soils among various agencies engaged in soil testing as a guide to fertilizer recommendations.

Selecting Fertilizers for Various Crops

In cooperation with the Agronomy and Horticulture Departments of the University of Connecticut, this Station has chosen the following standard-strength commercial mixed fertilizer grades to provide adequately for the various soil and crop needs in this State:

0-12-12	4-12-4
7-7-7	5-10-10
10-5-5	3-12-6
6-3-6	4-16-20
5-10-5	5-8-7
5-5-15	

Grades of higher concentration, supplying nitrogen, phosphoric acid and potash in these proportions, are advisable when correctly used in corresponding amounts, from the standpoint of economy. This Station has collaborated in preparing a publication outlining the selection and quantities of these grades for various conditions, printed as Bulletin 285 of the University of Connecticut Extension Service.

FOREST SOILS

Forest Nursery Fertilizer Studies

The fertilizer experiments of 1939 at Peoples Forest Nursery were repeated, with modifications, in 1940. On seedbeds (fall sown), white pine and Norway spruce plants receiving more than 200 pounds of nitrogen alone per acre were, on the whole, adversely affected. When P and K were included with moderate amounts of N, the plants were normal and appeared to make slightly more growth. With white spruce there were no significant differences. In the case of older stock (2-0 and 2-1) the response to treatment was considerably less than it was in 1939, due largely to seasonal differences. High applications of N (300-450 pounds per acre) alone, or with lesser amounts of P and K, were obviously injurious. The best results were obtained in most cases when the amount of phosphoric acid equalled or exceeded the amount of nitrogen. In the complete treatment potash was included, but there is no positive evidence that it has been beneficial.

The repeated use of sulfate of ammonia had increased the acidity of the soil, and in some beds which had received more than the usual dose there was a high mortality of plants. Apparently a pH below about 4.4 is unfavorable to spruce and pine, particularly if induced by physiologically acid fertilizers.

Vitamin B₁ and Starter Solution

The recent popular interest in Vitamin B₁ as an aid to plant growth, and the apparent success by some tomato growers in the use of starter solution (chemical fertilizer in dissolved form) at planting time led to the inclusion of these materials in the forest nursery experiments with Norway spruce and white spruce in the transplant bed at Peoples Forest Nursery. Neither B₁ nor starter solution, when used alone or in conjunction with a 6-10-3 fertilizer, had any consistent effect upon survival or growth during the growing season of 1940. In a field planting of small, unselected three-year-old Norway spruce trees in the Pachaug State Forest, there appeared to be some favorable response to both B₁ and starter. Additional results are needed before drawing conclusions, however.

Effect of Litter Removal and Liming

For the past 10 years the litter under red pine has been removed annually on some plots in the Rainbow Plantation. Studies are now in progress to ascertain the effect of such treatment with and without liming upon the physical and chemical properties of the soil. Indications are that removal by burning results in a slightly less acid condition of the upper three or four inches. Lime, applied in 1930, has reduced the acidity by 1.5 to 2 pH units to a depth of about six inches. The increase in available calcium in the mineral soil as the result of liming was considerably greater on the bare plots than it was where the litter was undisturbed. Lime also increased the availability of phosphorus. Removal of the litter by burning had a similar effect on the upper two inches of soil but not on the lower horizons. The removal of litter by either method seems to result in a somewhat lower available phosphorus content in the two to nine-inch depth.

TOBACCO SUBSTATION

DR. P. J. ANDERSON, in charge

THE new building for tobacco research at Windsor is nearly completed and the staff expects to move in before time for spring planting in 1941. This combination laboratory-service building replaces the inadequate wooden structure that dates from the founding of the Substation 20 years ago.

The tobacco industry has seen wide fluctuations during that time. In 1921, the peak of production had been reached with 31,000 acres planted to tobacco in the Connecticut Valley. Twelve years later depression, rise of cigarette smoking and other factors brought the area down to 12,000 acres. The past few years have seen a more

normal level with approximately 17,000 acres devoted to tobacco culture. This period has been marked by expansion of service and research at the Substation.

In February, 1940, Dr. Stuart LeCompte, Jr., was appointed Assistant Plant Physiologist succeeding Dr. O. E. Street.

Developing Improved Types of Shade Tobacco

During 1940 the Substation started a new breeding project in cooperation with the Research Committee of the Connecticut Leaf Dealers Association and the Genetics Department at New Haven. The object of the experiments is to improve the type of shade tobacco by selection, breeding or introduction of new varieties, along one or more of the following lines: higher yield, lighter colors, more high-grade leaves per plant, better leaf shape, better taste, resistance to diseases and insects. It may be found necessary to develop more than one type to satisfy different market demands.

During this first year many types and strains from which to make selections were planted. We made frequent observations on the growth and leaf characteristics and the variations in resistance to disease. In an effort to combine the good characters of two parents in one progeny, many crosses were made and the seed was planted in the greenhouse for winter growth. Other winter work will include sorting and comparing of the leaves from the different strains and varieties which were cured separately after harvest.

Mosaic Resistant Broadleaf

In a previous report it was mentioned that an effort was being made to breed a strain of Broadleaf resistant to the mosaic disease, "calico". This was started four years ago by crossing the Broadleaf variety with a highly resistant South American species of tobacco called *Ambalema*. The first generation hybrid was completely susceptible, but many plants of the second generation were resistant. The best of these were selected for two more generations, and crossed back to Broadleaf. Again selections were made for disease resistance and for Broadleaf characteristics and quality in the following generations.

In the field in 1940, the progeny of these plants were repeatedly inoculated in various stages of growth but none developed the typical symptoms of mosaic. Late in the season, when they were mature, a few showed mottled or dead areas on the lower leaves, indicating a probable masked mosaic condition. Most of the plants now have the Broadleaf characteristics but are not sufficiently "fixed" for general recommendation. Further selection and possibly further back crossing will be needed.

Placement of Fertilizers

It is the customary practice in this section to broadcast the fertilizer and harrow it into the soil a week or more before the tobacco is set in the field. In some sections, however, fertilizer is applied directly in the row at time of setting. Since various investigators

have shown that this method is most effective for a number of other row crops, a comparison of the two methods in field trials was started here in 1940 on a two-acre field divided into 48 plots for a three-way comparison. No consistent advantage of one method over the other was noted in the field but final results await the data on cured tobacco.

Studies on Fermentation of Tobacco

Studies of fermentation of tobacco have been continued along two lines: (1) changes in the bacterial and fungous flora of the fermenting leaves, and (2) chemical changes during the process.

Previous investigations showed that in the early stages of fermentation the yeasts were beneficial, but that they soon disappeared from the fermenting pile. After Dr. O. E. Street left Windsor, the investigation was turned to the other organisms (bacteria and fungi) which might have an important role in fermentation. This work has been started in cooperation with Dr. D. W. McKinstry of Bloch Bros. Tobacco Company.

To date, results have shown that the fungi rapidly decrease in abundance during the fermentation, the rate of disappearance, however, depending on the species involved. At the same time the bacteria increase.

The present study reveals a gradual increase in the pH of fermenting tobacco accompanied by changes in the nitrogen, organic acid and resin fractions of the leaf. The nicotine, amide-nitrogen, nitrate-nitrogen, and non-volatile organic acid content of the tissue diminishes during fermentation; volatile organic acids increase during the sweating and undergo chemical changes of a nature as yet undetermined. A close correlation was observed between the rate and extent of chemical change and the increase in number and activity of the bacterial population of the leaf.

Spacing Tests

The only two conclusions warranted at present in the spacing tests at Windsor are that the acre yield may be raised by decreasing the distance between plants, and that wider spacing produces thicker leaves. Havana Seed tobacco is used in these experiments and all applicable tests are made to measure the variation in yield, quality, leaf size, shape and thickness as related to different spacing of plants in the row.

Chemical Composition of Leaves

That the upper leaves of the tobacco plant are different from the lower leaves in color, thickness and other physical characteristics, as well as in taste, burn and suitability for different brands of cigars is well known to all tobacco handlers. For several years we have been investigating the chemical composition of leaves according to their position on the stalk to determine whether the chemical differences are related to the physical.

Each successive leaf from bottom to top of stalk on 36 plants was analyzed separately. The results, showing progressive increases or decreases in percentages of the important elements and compounds, have been determined and are presented in the *Report of the Tobacco Substation for 1939*, Bulletin 433.

Relation of Calcium to Growth and Quality

Very little information is at hand on the influence of calcium without reference to its effect on soil reaction in tobacco fields. In order to determine the effect of the element itself, calcium was applied in the present experiments in a mixture of the nitrate, sulfate and hydrate. On duplicate field plots, three different quantities were used annually for four years and the results, compared with those on untreated plots, follow:

There was no appreciable difference in the soil reaction of the plots.

Differing amounts of calcium produced no significant increase or decrease in yield.

The grading of the cured crop improved with each increase in calcium, the effect showing in the higher percentage of lighter, more valuable grades (light wrappers and long seconds) and a corresponding decrease in the darker, heavier (cheaper) grades.

Increased calcium reduced somewhat the length of burn on single leaves. When, however, the burn was tested by using the fermented leaves on cigars, the combustion was improved. It was more complete, giving a whiter ash; the burn was closer (narrower coal band) and the taste better.

Black Tobacco Research Project

A tobacco leaf which cures very dark brown, with a blue-gray or purple-gray cast, is called "black" tobacco by growers and is a recurrent and serious trouble to them. It has low sale value because of its undesirable color. It is said to be more abundant some years than others. On some farms it seldom occurs; on others it constitutes a considerable portion of the crop, being harvested from scattered points in a field, from definite patches within a field, or even from whole fields, while nearby lots produce high quality leaf. It is found in crops of Shade, Havana Seed and Broadleaf tobacco but has attracted most attention in Shade tobacco.

Through the courtesy of growers and dealers, numerous sample hands of "black" tobacco have been collected from widely scattered localities in the Connecticut Valley. At the same time, for the sake of comparison, there have been collected sample hands of good, light-colored leaves from the same farms or even from the same lots which produced the black hands. In a preliminary chemical examination, these hands have been analyzed principally for the ash constituents, manganese and iron. A small number of sample hands have been analyzed for total nitrogen, phosphorus, potassium, calcium and magnesium. All elements in this analysis were found in concentrations that have been reported by other workers as normal for good quality

tobacco. The greater content of manganese and iron in the black leaves suggests that the black tobaccos may have been grown on a soil more acid than the soil which produced the light-colored leaves.

In order to probe this suggested relationship between plant and soil, collection and chemical study of black tobacco are being continued and, when possible, the soil where such tobacco grew is being tested.

Insect Investigations

Since 1936, investigations on the control of insects attacking tobacco have been carried on in cooperation with the U. S. Department of Agriculture. These have centered mainly on the control of three major pests: the potato flea beetle, the tobacco thrips and the wireworm.

Measures tested for use against the first two included dusts and sprays containing cubé root powder and pyrethrum, used alone and in various combinations. Of these, cubé root powder, diluted with sterilized tobacco dust to contain 1 percent of rotenone, gave highly satisfactory control of the flea beetle when used twice weekly at rates averaging about 7 to 8 pounds per acre. It did not exert any appreciable control of the thrips. Pyrethrum powder of the so-called "impregnated" type gave apparently satisfactory control of both flea beetle and thrips when used similarly but was less effective than the cubé against the flea beetle. These data need corroboration, however. Sprays did not provide sufficient control.

Control of wireworms was attempted by means of 93 percent purified naphthalene plowed into the soil at rates of 800 and 1,000 pounds per acre. The reduction of population was statistically significant, but not satisfactory from a practical standpoint and further study is needed on this pressing problem.

In addition, field surveys were made to ascertain the insect situation on tobacco throughout the Connecticut River Valley for comparison with similar data from previous years. A development which should be carefully watched, though it is not likely to become serious, is the attack on sun and shade grown tobacco by Japanese beetles. This was first noted in 1939 and occurred again in 1940.

CONNECTICUT TREE PROTECTION EXAMINING BOARD

THE General Assembly of 1919 provided that the botanist, entomologist and forester of this Station should act as an examining board to pass on the qualifications of tree workers and issue certificates to those found qualified. Connecticut was the first State to enact such a law but has been followed by Rhode Island, Maine and New Hampshire. Other states are considering similar action.

This board was organized on July 1, 1919, and for 20 years functioned as an agency of the Station. Reports on the activities of the board were published at intervals as Station circulars.

The statute was amended in 1939 to provide for appointment by the Governor of two additional members of the board. Organization of the new board took place July 1, 1939. Although three members of the Station Staff still constitute a majority, the board now functions as a state licensing agency and not as a service of this Station. Consequently, its reports will no longer appear as Station publications.

During the 20 years of its existence, the original board examined over 600 applicants and issued a total of 526 certificates. Occasional institutes for tree workers were held and examination standards were consistently raised throughout the period.

The Connecticut board took the initiative in calling a shade tree conference at Stamford in 1923. This has now become a permanent organization, supported financially by the professional tree workers of the entire country, and the annual meetings of the National Shade Tree Conference, with its published "Proceedings" have done much to raise the standards of tree workers throughout the U. S. Connecticut's pioneer work in this line has thus had widespread influence.

MOSQUITO ELIMINATION

THE mosquito control work is carried out by a State Board of which the Director of this Station is a member. Since no provision has been made for any publication by this Board, the report is included here.

No serious mosquito nuisances were observed or reported in the areas, including 11,000 acres of salt marsh, maintained by the State. Routine maintenance of ditches, some spur ditching, and oiling of small breeding areas have been carried out as usual. W. P. A. mosquito control projects were reduced in scope for various reasons, and on December 10, 1940, the Board was notified that the statewide projects sponsored by the Board would no longer be carried out by the W. P. A. Ditching, Draining, and Pest Control Project, nor would any agency of the latter organization render further engineering services or aid in obtaining releases. Individual projects would be administered by the local area offices of the W. P. A. Local agencies are now continuing some local projects. It is anticipated that all W. P. A. work on mosquito control will terminate in 1941.

The Agent of the Board conducted a field trip of the Eastern Association of Mosquito Control Workers on June 27, 1940, which covered some of the W. P. A. projects in the State.

A more detailed report on mosquito control will be published in the report of the State Entomologist for 1940.

THE LIBRARY

DURING the year ended October 31, 1940, the Station Library had approximately the following number of additions:

U. S. Department of Agriculture publications	698
State Agricultural Experiment Stations publications	855
Scientific and agricultural domestic and foreign journals (separates)	2,000
Single books purchased	45
Total	3,598

The library subscribes to 90 sets of scientific journals. It receives in return for the publications of this Station about 25 sets of domestic farm journals and 26 sets of foreign agricultural journals.

The total number of cloth and paper bound volumes on hand is now about 26,300. Most of the United States Department of Agriculture and State Experiment Stations publications, as well as scientific journals, are received in pamphlet form and are not included in the volume count until bound.

PUBLICATIONS

July, 1939 to July, 1940

BULLETINS OF THE STATION

- REPORT ON FOOD PRODUCTS AND DRUGS FOR 1938. E. M. Bailey. No. 426.
- VOLUME TABLES FOR PLANTATION GROWN WHITE PINE, *Pinus Strobus*, L. IN CONNECTICUT. Henry W. Hicock, Arnold D. Rhodes, and A. Richard Olson. No. 427.
- CONNECTICUT STATE ENTOMOLOGIST. 38th Report, 1938. W. E. Britton. No. 428.
- SEASONAL WATER AND NITRATE LEACHINGS IN RELATION TO SOIL AND SOURCE OF FERTILIZER NITROGEN. M. F. Morgan and O. E. Street. No. 429.
- COMMERCIAL FERTILIZERS. Report for 1939. E. M. Bailey. No. 430.
- TETRANYCHIDAE OF CONNECTICUT. Philip Garman. No. 431.
- DISEASES AND DECAYS OF CONNECTICUT TOBACCO. P. J. Anderson. No. 432.
- TOBACCO SUBSTATION AT WINDSOR. Report for 1939. P. J. Anderson, T. R. Swanback, and O. E. Street. No. 433.
- CONNECTICUT STATE ENTOMOLOGIST. 39th Report, 1939. No. 434.

CIRCULARS OF THE STATION

- THE SHELTON AND HEBRON STRAWBERRIES. D. F. Jones and W. R. Singleton. No. 137.
- EARLY SWEET CORN HYBRIDS. SPANCROSS, MARCROSS AND CARMELCROSS. W. R. Singleton and D. F. Jones. No. 138.
- TURF MANAGEMENT. M. F. Morgan, E. M. Stoddard, and J. P. Johnson. No. 139.
- ORIENTAL FRUIT MOTH PARASITES. Philip Garman. No. 140.
- LAWS AND REGULATIONS CONCERNING THE INSPECTION OF NURSERIES IN CONNECTICUT AND TRANSPORTATION OF NURSERY STOCK. R. B. Friend and M. P. Zappe. No. 141.
- PEAT AND SWAMP MUCK FOR SOIL IMPROVEMENT IN CONNECTICUT. M. F. Morgan. No. 142.

JOURNAL PAPERS

- BEARD, RAIMON L. Parasitic castration of *Anasa tristis* DeG. by *Trichopoda pennipes* Fab., and its effect on reproduction. Jour. Econ. Ent. 33:269-272. 1940.
- BOTSFORD, R. C. Mosquito control in Connecticut, 1939. N. J. Mosq. Extermin. Assoc. Proc., pp. 101-102. 1940.
- CLARK, FRANCES J., and COPELAND, FREDERICK C. Chromosome aberrations in the endosperm of maize. Amer. Jour. Bot., 27:247-251. 1940.
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- _____. Report on parasite work for 1939. Conn. Pomol. Soc. Proc., pp. 92-93. 1940.
- _____. Seasonal notes on insects and sprays. Pomological Pointers for Conn. Fruit Growers. April, 1940.
- _____. The outlook for insects. The Rural New Yorker, 99:164. 1940.
- GARMAN, PHILIP, and ZAPPE, M. P. Report of committee on injurious insects. Conn. Pomol. Soc. Proc., pp. 86-89. 1940.
- HEUBERGER, J. W., and HORSFALL, J. G. Maintaining quality of tomatoes by delayed spraying. Phytopath., 30:9. 1940.
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- . Strawberry red stele appears in Connecticut. Plant Disease Reporter, 23:249. 1939.
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- STODDARD, E. M., McDONNELL, A. D., and HICOCK, H. W. Fomes annosus on conifers in Connecticut. Plant Disease Reporter, 23:385-386. 1939.
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LIST OF PROJECTS

1940-41

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs. (Including biological assays of vitamin D supplements for poultry feeds.)
3. Inspection of food and drugs. (Including biological assays of vitamin D milk.)
4. Calibration of Babcock glassware and thermometers.
5. Analyses of insecticides and fungicides.
7. Analyses of special and miscellaneous foods.
8. Collaborative studies on analytical methods.

Biochemistry

1. Cell chemistry.
 - a. A detailed examination of the constituents of plant cells, in particular those of leaf tissues. The further development of methods for the determination of the constituents in extracts of such tissues.
 - b. Chemical investigations of the constituents of the tobacco and other plants with special reference to the changes that occur during culture under various conditions.
 - e. The metabolism of the organic acids in plants.
2. Protein chemistry.
 - a. The methods for the determination of the basic amino acids yielded by proteins with the object of increasing their accuracy and convenience.
 - b. The methods for the separation of other amino acids yielded by proteins.
 - c. The properties of certain of the amino acids and their derivatives.
 - d. Methods for the preparation of pure proteins.
3. Nutrition investigations.
 - a. The relation of diet to the rate of growth with special attention to certain factors that appear to determine rapid growth.
 - b. The investigation of the relation of certain constituents of the diet, especially the mineral salts, to growth.

Entomology

9. Insect survey of Connecticut.
17. Studies on the control of the Oriental fruit moth, including parasites. (In coöperation with the U. S. Dept. of Agr.)
28. Investigations on oil sprays.
30. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Tobacco Substation, No. 20.)
31. Studies on the biology and control of the European pine shoot moth.
34. Tests of methods to control clothes moths. (Inactive)
35. The biology and control of the white apple leafhopper. (Inactive)
36. Methods for the control of onion thrips.
37. Substitutes for lead arsenate in orchard sprays.
38. The relation of rate of growth and pruning methods to the recovery of white pine to weevil injury.
40. Studies on the control of the European corn borer. (In coöperation with the U. S. Dept. Agr.)
41. Studies on the corn ear worm. (In coöperation with the U. S. Dept. Agr.) (Inactive)
42. The biology and control of termites.
43. The spruce gall aphid.
44. Bark beetles of the elm.
45. Investigation of parasites of the Japanese beetle.
47. Value of derris dusts in the control of aphids.
48. Study of predators affecting the European red mite.

49. Adhesives for standard spray mixtures.
50. Control of the squash vine borer.
51. Soil and grassland insect investigations.
52. Study of wireworm injury to potatoes.
53. Rodent control. (In coöperation with the U. S. Fish and Wildlife Service.)

Control and Service

10. Inspection of orchards and nurseries.
11. Control of the gypsy moth. (In coöperation with the U. S. Dept. Agr.)
13. Inspection of apiaries.
19. Control of European corn borer. (In coöperation with the U. S. Dept. Agr.)
(Inactive)
25. Control of the Japanese beetle. (In coöperation with the U. S. Dept. Agr.)
27. Rearing and distributing parasites of the Oriental fruit moth. (In coöperation with the Conn. Pomological Society.)
29. Dutch elm disease control. (In coöperation with the U. S. Dept. Agr.)

Forestry

1. Experimental plantations on a sandy tract at Rainbow.
 - a. Comparison of many species of conifers and hardwoods, in pure stands and in combinations, as to growth and habits.
 - b. Methods of management for those species that have survived.
 - c. The properties of the wood of several of the important species. (In coöperation with the Yale Forestry School.)
6. Studies of forest plantations throughout the State.
 - a. Growth and yield of several species in relation to site. (The present studies are on red pine, in coöperation with the State Forester and the Yale Forestry School.)
 - b. Properties of red pine wood grown in plantations. (In coöperation with the Yale Forestry School.)
12. The utilization of native woods. (In coöperation with the State Forester, State Highway Dept., Conn. Forest & Park Assoc., Yale Forestry School, and U. S. Forest Service.)
 - a. Preservative treatments of posts and other materials.
 - b. The development of a portable metal charcoal kiln.
 - c. The use of hogged wood as a fuel.

Control and Service

5. Distribution of forest planting stock. (In coöperation with the U. S. Dept. Agr.)
7. Control of white pine blister rust. (In coöperation with the U. S. Dept. Agr.)

Genetics (Plant Breeding)

1. A genetic and cytological study of hereditary characters in plants.
2. The effect of inbreeding and crossing upon seed and vegetatively propagated plants.
3. Methods for the improvement of naturally cross-fertilized plants by selection in inbred lines.
4. Methods for the improvement of naturally self-fertilized plants.
5. A genetic and physiological study of variation and the effects of selection in vegetables and fruits.

Plant Pathology and Botany

5. Plant disease survey of Connecticut.
20. Diseases of shade trees.
27. The Dutch elm disease and related diseases.
28. Studies on the identification of apple varieties by seed characters. (Inactive)
30. Diseases of vegetable crops and their control.
 - a. Downy mildew of muskmelons and cucumbers.

- b. Defoliation and related diseases of tomatoes.
- c. Root rot of squash.
- d. Wilt diseases of tomatoes and eggplant.
- 31. Investigation of the X-disease of peach.
- 33. Diseases of ornamental plants.
 - a. Geranium root rot.
 - b. Botrytis blight on tulips.
 - c. Root rot of delphinium.
 - d. Powdery mildew diseases—lilac, phlox, etc.
 - e. Rose diseases—powdery mildew, black spot.
 - f. Carnation and hollyhock rust.
 - g. Chrysanthemum nematode.
- 34. Fungicides, new and old.
- 35. Apple spraying.

Control and Service

- 12. Seed testing. (In coöperation with the Commissioner of Agriculture.)
- 25. Spray service. (In coöperation with Extension Service, University of Conn.)

Soils

- 2. The physical and chemical characteristics of soils representing important types and cultural uses in relation to the nutritive responses of tobacco and other indicator crops in pot trials.
- 3. Nutrient requirements of vegetable crops on important soil types used for market gardening in Connecticut.
- 4. A study of the physical, chemical and biological conditions of several soil types in natural mixed hardwoods and in planted coniferous forests.
- 5. Lysimeter studies of the drainage losses and other changes that occur in soils under heavy fertilization as practised for tobacco and vegetables.
- 7. The improvement of the nutritional status of unproductive forest soils.
- 8. The agronomic application of rapid chemical tests for estimating the nutritional factors of soil fertility.
- 9. The evaluation of various soil factors in terms of land use and types of farming.
- 10. Nitrogen relationships in soil maintenance by green manures in vegetable cropping systems.

Tobacco Substation

- 1. Fertilizer experiments.
 - ba. The efficiency of Urea nitrogen compared with organic nitrogen.
 - bb. The relative efficiency of nitrogen from castor pomace, soybean oil meal and cottonseed meal.
 - e. Comparison of various single sources of nitrogen.
 - fa. Comparison of sources of phosphorus.
 - ga. Fertilizer placement tests.
- 4. Tobacco nutrition studies.
 - d. Symptoms of food element deficiency.
 - h. Ammonification and nitrification of fertilizer materials.
- 5d. Comparison of Havana seed strains. (In coöperation with the U. S. Dept. Agr.)
- 7aa. Improvement of Shade tobacco by selection and breeding. In coöperation with the Conn. Leaf Dealers Assoc.)
- 8b. Effect of cover crops on leaching. (See also Soils, No. 5.)
- 13. Preservative treatment of shade tent poles. See also Forestry, No. 12.)
- 17b. The study of the cause of black Shade tobacco.
- 19. Investigation of various tobacco diseases.
 - c. Pole rot.
 - e. Breeding for mosaic resistant Broadleaf.
 - f. Control of downy mildew.
 - h. Breeding for resistance to downy mildew.
- 20. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Entomology, No. 30.)

- a. Control of wireworms.
 - b. Control of flea beetles.
 - c. Control of thrips.
 - 22. Irrigation of tobacco.
 - 25. Spacing of Havana Seed tobacco.
 - 26. Chlopicrin for sterilization of tobacco bed soil.
 - 27. Tests of lumarith for seedbed covers.
 - 29. Changes in fungus and bacterial flora during the fermentation of tobacco. (In coöperation with Bloch Bros. Tobacco Co.)
 - 30. Chemical investigations. (In coöperation with the American Tobacco Co.)
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All of which is respectfully submitted.

WILLIAM L. SLATE,

Director.

REPORT OF THE TREASURER

W. L. Slate, Treasurer, in account with the Connecticut Agricultural Experiment Station.

July 1, 1939 to June 30, 1940

INCOME

STATE APPROPRIATIONS:

Station General Fund	\$247,100.00
Special:	
Dutch Elm Disease (Bal. of 1937 Appropriation)	6,223.90
Construction of Greenhouses	15,000.00
Feed Fees	17,065.00
Fertilizer Fees	12,655.00
Miscellaneous	238.93
Trust Fund	5,634.50

FEDERAL APPROPRIATIONS:

Hatch	7,500.00
Adams	7,500.00
Purnell	30,000.00
Bankhead-Jones	10,329.04
	<hr/>
	\$359,246.37
Unexpended funds returned to State	
Treasurer at end of year	44,472.96
	<hr/>
Net Income	\$314,773.41

FINANCIAL STATEMENT
July 1, 1939 to June 30, 1940
EXPENDITURES

	Personal Services	Contractual Services	Supplies and Materials	Capital Outlay	Total
State Appropriation:					
Station General Fund	\$ 68,935.59	\$ 3,734.50	\$ 5,457.68	\$ 3,844.94	\$ 81,972.71
Bee Diseases	1,200.00	884.95	.....	.....	2,084.95
Food and Drug Analyses	9,533.93	381.10	421.57	88.76	10,425.36
Gypsy Moth Suppression	42,679.52	831.68	3,517.64	932.00	47,960.84
Insect Pest Control and Research	43,832.72	1,980.89	1,895.40	1,625.34	49,334.35
Mosquito Elimination	10,255.15	1,661.33	64.64	.....	11,981.12
Tobacco Substation	14,526.21	793.66	1,189.99	1,096.21	17,606.07
White Pine Blister Rust Control	3,723.85	854.81	145.41	.....	4,724.07
Special Dutch Elm Disease Fund	1,120.00	885.45	52.43	.....	2,057.88
Construction of Greenhouses .....	.....	.....	.....	.....	.....
Federal Funds	50,957.60	1,712.52	2,319.24	339.68	55,329.04
Feed Inspection	15,210.00	750.33	634.02	199.60	16,793.95
Fertilizer Inspection	10,920.00	574.55	629.03	263.10	12,386.68
Trust Fund	2,988.34	338.61	1,497.43	.....	4,824.38
	<u>\$275,882.91</u>	<u>\$15,384.38</u>	<u>\$17,824.48</u>	<u>\$8,389.63</u>	<u>\$317,481.40</u>
Less Reimbursements	2,687.27	17.23	3.49	.....	2,707.99
Net Expenditures	<u>\$273,195.64</u>	<u>\$15,367.15</u>	<u>\$17,820.99</u>	<u>\$8,389.63</u>	<u>\$314,773.41</u>

WHAT THE STATION CAN DO

Each mail brings to the Station requests for information and service, the range of subjects being almost without limit. Every effort is made to comply with these requests, even though they are outside the fields under investigation. This is one of the purposes for which the library is maintained. However, some of the letters request help that requires an intimate knowledge of livestock management and the like, and others ask us to make laboratory determinations for which we do not have the equipment or staff. Therefore, it is helpful to publish from time to time a list of the subjects on which we are best equipped to furnish information and the kinds of samples we can accept.

The Station can furnish information on:

- Fertilizers and fertilization.
- Soils and their management.
- The chemical composition of foods, drugs, insecticides and fungicides.
- Insect pests of plants and their control.
- Fungous and other diseases of plants and their control.
- Sprays and spraying.
- Fruits and fruit management.
- Weeds and their control.
- Forestry—all phases.
- Care of shade trees, all phases.
- Plant breeding.
- Lawns, establishment and care.
- Bees.
- Mosquito elimination.
- Tobacco.
- Vegetables, especially varieties and strains.

Samples and specimens that can be analyzed, tested or identified:

- Fertilizers.
- Feeding stuffs.
- Foods and drugs.
- Milk—except for bacterial count.
- Seeds.
- Weeds and other plants.
- Insects.
- Diseased and injured plants.
- Soils.

The Station does not furnish information on:

- Livestock feeding and management, including poultry.
- Animal diseases.
- Household management.
- Clothing.
- Farm management.
- Markets and marketing.

Requests for information on these subjects should be sent to the University of Connecticut, Storrs.

The Station cannot make analyses and examinations of:

- Drinking water—apply to the Town Health Officer.
- Milk for bacterial content—apply to the Dairy and Food Commissioner, Hartford.
- Sick or dead poultry should be sent to the Animal Diseases Laboratory, University of Connecticut, Storrs.



University of
Connecticut
Libraries



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